UG REVISED REGULATIONS 2020 (V1.0)

Outcome based Learning through choice based credit system
(For students admitted from 2021-2022 and onwards)

B.E. MECHANICAL ENGINEERING

Curriculum and Syllabus



Website : www.srec.ac.in

SRI RAMAKRISHNA ENGINEERING COLLEGE

[Educational Service : SNR Sons Charitable Trust]
[Autonomous Institution, Reaccredited by NAAC with 'A+' Grade]
[Approved by AICTE and Permanently Affiliated to Anna University, Chennai]
[ISO 9001:2015 Certified and all eligible programmes Reaccredited by NBA]
Vattamalaipalayam, N.G.G.O. Colony Post, Coimbatore-641022

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ENLIGHTENMENT THROUGH EDUCATION
SREC

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Information on the minimum number of credits to be earned for the successful completion of B.E.. / B.Tech. programmes for

† **Regular candidates (4 years) : 162 credits**

† **Lateral Entry candidates (3 years) : 120 credits**

Chairperson Academic Council/Principal

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Sri Ramakrishna Engineering College was established in the year 1994 by SNR Sons Charitable Trust. It is an Autonomous Institution since 2007 and accredited by NAAC with 'A' Grade. The Institution offers 10 Undergraduate Programs and 7 Post Graduate Programs in Engineering and Technology along with MBA. All eligible Programs have been accredited and reaccredited by the NBA, New Delhi.

HIGHLIGHTS OF THE CURRICULUM

- Outcome based education with Student centric learning through Choice Based Credit System
- Industry driven learning with multi disciplinary approach
- Project-based learning
- Competency enhancement courses including on-line learning
- Collaborations with Premier Institutions-National and International
- Certification courses in foreign languages
- One credit courses offered by Industries and Research establishments
- Employability enhancement courses focusing on placements
- Industry Internship opportunities
- Inculcates Innovation, startup culture and Entrepreneurship development
- Syllabi development based on emerging technologies
- Active learning methods
- Assessment based on student learning levels
- Periodic programme outcome review within the broad framework of agreed expected graduate attributes

VISION AND MISSION OF THE INSTITUTION



VISION

To develop into a leading word class Technological University consisting of Schools of Excellence in various disciplines; with a co-existent Centre for Engineering Solutions Development for worldwide clientele.



MISSION

To provide all necessary inputs to the students for them to grow into knowledge engineers and scientists attaining.

Excellence in domain knowledge, practice and theory

Excellence in co-curricular and Extra-curricular talents

Excellence in character and personality

ENLIGHTENMENT THROUGH EDUCATION SREC

SRI RAMAKRISHNA ENGINEERING COLLEGE, COIMBATORE - 641 022

(An Autonomous Institution, Permanently Affiliated to Anna University, Chennai)

REVISED REGULATIONS 2020 (V1.0)

Outcome based learning through choice based credit system

For all B.E.. / B.Tech. Full-Time Programmes

(For the students admitted to B.E.. / B.Tech. Programmes from the Academic year 2021-2022 and onwards)

PREAMBLE

Sri Ramakrishna Engineering College with a focused vision and mission of imparting quality technical education in domain knowledge, both theory and practice is gearing up for several initiatives towards academic excellence and quality improvement. In view of this the Outcome based Education through Choice Based Credit System (CBCS) is being introduced from the Academic year 2021-2022, to strengthen interdisciplinary and multidisciplinary approach with advances in learner-centric programmes and life- long learning opportunities with enriched and flexible contents. The industry interaction initiative provides a meaningful linkage between the challenging professional world and the academia. The programmes are designed with science, applied science and technology components along with liberal arts forthe graduates of the various programmes to function efficiently and effectively in the technological society.

The proposed academic structure under the Outcome based education through Choice Based Credit System shall make innovations possible preparing the students to work as a team and face the professional challenges through learning additional courses as specialization /minor courses. The proposed systems creates ample environment for self learning, innovation leading to a startup culture and Entrepreneurship development which is supported by the institution.

SCOPE

The regulations provided herein shall apply to all Regular, Professional and General Undergraduate (UG) programmes offered in SREC.

These regulations are quite comprehensive and include definitions of key terms, critical concepts, mechanics of calculations, role of various boards and committees and the evaluation system.

1. PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise specifies:

1. **"Programme"** means under graduate degree programme.i.e., B.E.. / B.Tech. Degree Programme.
2. **"Specialization"** means discipline of B.E.. / B.Tech. Degree Programme, like Mechanical Engineering, Information Technology, etc.,
3. **"Course"** means a Theory / Integrated or Practical course that is normally studied in a semester, like Engineering Graphics, Fundamentals of Computing and Programming, etc.,
4. **"Head of the Institution"** means the Principal of the College /Institution
5 **"Head of the Department"** means Head of the Department concerned.
6. **"University"** means affiliating University, currently, **ANNA UNIVERSITY, CHENNAI**

2. ADMISSION CRITERIA

The Admission Criteria for all Programmes will be as per the norms of the Directorate of Technical Education and the Affiliating University.

Lateral Entry Candidates

i. The candidates who possess the Diploma in Engineering / Technology awarded by the State Board of Technical Education, Tamil Nadu or its equivalent are eligible to apply for admission to the third semester of B.E.. / B.Tech. Programme corresponding to the branch of study.

(OR)

ii. The candidates who possess the Degree in Science (B.Sc.) (10+2+3 stream) with mathematics as a course at the B.Sc. level are eligible to apply for admission to the third semester of B.E.. / B.Tech. Such candidates shall undergo two additional engineering courses in the third or fifth and fourth or sixth semesters respectively as prescribed by the respective Chairman of Board of Studies.

3. DURATION OF THE PROGRAMME

The four academic years will be divided into eight semesters with two semesters per academic year. Each semester shall normally consist of 90 working days including examination days.

Degree	Stipulated number of Semesters	Permitted number of Semesters
B.E./B.Tech (Regular)	8	14
B.E./B.Tech (Lateral)	6	12

The permitted number of Semesters can be increased on a case to case basis subject to the approval of the Academic Council and the affiliating university.

The total period for completing the programme is reckoned from the commencement of the first Semester of the programme to which the candidate is admitted and it shall not exceed the maximum period specified irrespective of the period in break of study in order that he/she may be eligible for the award of the degree

The ongoing degree programmes in Bachelor of Engineering / Technology are given below:-

B.E. Civil Engineering

B.E. Mechanical Engineering

B.E. Electrical and Electronics Engineering

B.E. Electronics and Communication Engineering

B.E. Electronics and Instrumentation Engineering

B.E. Computer Science and Engineering

B.E. Biomedical Engineering

B.E. Aeronautical Engineering

B.E. Robotics and Automation

B. Tech Information Technology

B. Tech Artificial Intelligence and Data Science

M. Tech Computer Science and Engineering (5 years Integrated)

4. STRUCTURE OF THE PROGRAMMES

The Curriculum and Syllabi under Regulations 2020 are implemented based on the recommendations of Model Curriculum by **AICTE, New Delhi and UGC, New Delhi** with a view of achieving excellence in the quality of education by keeping the requirements of enhancing the employability Skill and producing well-rounded engineers for the benefit of Industry, Society and Nation as a whole.

The outcome based learning through CBCS enables the students to earn credits across programmes and provides flexibility for slow and fast learners in registering the required number of credits in a semester. The CBCS facilitates the transfer of credits earned in different departments / Centers of other recognized / accredited universities or institutions of higher education in India and abroad either by studying directly or by online method.

The curriculum of every programme is designed with a minimum number of credits to be earned, to be eligible for the award to degree is **162** (**120** for lateral entry).

5. CATEGORIZATION OF COURSES

Every B.E../B.Tech. Programme will have a curriculum with syllabi consisting of theory and practical courses that shall be categorized as follows:

Category of Course	D Description	Credits
Humanities and Social Sciences including Management courses **[HSMC]**	Courses include Technical English, Employability Skills, Engineering Ethics and Human Values, Communication skills and Management courses	**9-11**
Basic Science courses **[BSC]**	Courses include Chemistry, Physics, Biology and Mathematics	**23-25**
Engineering Science courses including workshop drawing, basics of electrical /mechanical/ computer etc **[ESC]**	Courses include Workshop, Drawing, Basics of Electrical / Electronics / Mechanical / Civil / Computer / Instrumentation Engineering	**25-27**
Professional core courses **[PCC]**	Courses include the core courses relevant to the chosen programme of study	**57**
Professional Elective courses relevant to chosen specialization/branch **[PEC]**	Courses include. elective courses relevant to the chosen programme of study.	**18**
Open subjects - Electives from other technical and /or emerging subjects **[OPC]**	Courses include inter-disciplinary courses which are offered in other Engineering/ Technology Programme of study	**09**
Project work, seminar and internship in industry or elsewhere/Skill Development Courses (SDC) / **[EEC]**	Courses include the courses such as Project, Seminar and Inplant training / Internship for improving Employability Skills	**15**
Mandatory Courses **[MC]**	Courses include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc.	**Non-Credited**
		162

- Curriculum of a semester shall normally have a blend of 5 or 6 lecture courses and laboratory courses.
- Employability Enhancement Course(s) may also be included. Credit will be assigned to each course.
- However, the total number of courses per semester shall not exceed 8/9 (including EEC).
- The medium of instruction is English for all courses.

Each course is assigned certain number of credits based on the following:

Contact period per week	Credits
1 Lecture Period	1
1 Tutorial Period	1
2/3 Practical Periods	1
(Laboratory / Seminar / Project Work / etc.)	1-8

6. INDUCTION PROGRAMME

- All students shall undergo induction program in the first semester for duration as per the guidelines of All India Council for Technical Education (AICTE).
- All student have to attend and complete the induction programme.
- A student who does not complete the induction programme in the first semester shall do the same in the when offered next.

7. COURSE ENROLLMENT AND REGISTRATION

- Each student, on admission shall be assigned to a student faculty advisor who shall advice and counsel the student about the details of the academic programme and the choice of courses considering the students' academic background and career objectives
- Every student shall enroll for the course of the succeeding semester in the current semester. However, the student shall confirm the enrollment by registering for the courses with in the first five working days after the commencement of the concerned semester.
- No course shall be offered by a Department unless a minimum of 15 students register for that course.
- After registering for a course, a student shall attend the classes, satisfy the attendance requirements for that course, earn Continuous Assessment Marks and appear for the Semester end examinations.
- Each student on admission shall register for all the courses prescribed in the curriculum in the student's First Semester of study.
- The enrollment for the courses of the semesters 2 to 8 will commence 10 working days prior to the last working day of the preceding semester. The student shall enroll for the courses with the guidance of the student's Faculty Advisor.
- The curriculum for any semester except for final semester will normally carry credits between 21 and 25.

8. DIRECT SELF STUDY ELECTIVE COURSES

- All B.E.. / B.Tech. degree programme candidates who have earned a CGPA of 7.50 and above up and who have no standing arrears will be eligible to take one elective course as Self Study course, which may be either an Open Elective or a Professional Elective by getting prior approval from the HoD who will nominate a faculty for the periodic monitoring and continuous evaluation of the course.
- The candidate has to register with the office of the Controller of Examinations through the Academic Coordinator & Head of the Department with in the first 15 working days of the respective semesters.

- The grade for the course will be based on the continuous assessment by the mentor and the performance of the candidate in the semester end examinations.
- The candidate is also permitted to study a course / a topic of candidate choice.
- The syllabus for such course which is not part of any of the curricula of the programmes offered in the Institution - but are courses from Emerging Technologies will be considered
- The Mode of assessments for such courses shall be approved by the Programme Assessment Committee and forwarded to the Chair Person, Academic Council for the formal approval of the course by the academic bodies.

9. OPEN ELECTIVE COURSES

- Open Elective courses include the elective courses relevant to the chosen discipline which a candidate can choose from the curriculum of other B.E../B.Tech. programmes and elective courses offered by the Departments under the faculty of Science and Humanities.
- Open elective courses generally will not require any pre-requisite course of that programme

Please note the following when selecting your open elective/s:

- Some open elective courses may not be appropriate as an open course for a particular degree program.

  Example: Business Degree courses are not considered open for students in a business degree program.
- Some open elective courses may not be offered in the current academic semester or year.
- Some open elective courses may reach capacity early and therefore space may not be available for all interested students.
- Therefore, students who enroll early are most likely to get their choice.
- Students are responsible for ensuring that they successfully complete all courses as required by the program design, in order to graduate.

10. GLOBAL INITIATIVE OF ACADEMIC NETWORKS (GIAN)

- **Two weeks / Ten days** courses offered under the Global Initiative of Academic Networks (GIAN) program of MHRD conducted at premier institutes can be **considered instead of one elective course.**

11. ONE CREDIT COURSES

- Candidates can also opt for one credit industry oriented courses of 15 to 20 hours duration, which will be offered by experts from industry/ other institution/our faculty on specialized topics.
- Candidates can complete such one credit courses during the semesters 3 to 7 as and when these courses are offered by different departments.
- A candidate will also be permitted to register for the one credit courses of other departments provided the candidate has fulfilled the necessary pre-requisites (if any required) of the course being offered subject to approval by both the Heads of the Departments.

- If a candidate wants to avail exemption of electives, he/she can do so by exercising his/her option in writing to the respective Head of the Department during the beginning of the semester. The equivalent norms will be that one elective is equivalent to three one credit courses successfully completed by the candidate.
- One credit courses will be evaluated by the course instructor / department faculty concerned. A total of 100 marks will be assessed by continuous assessment only; of which 75% weightage will be for final test to be scheduled by the course instructor / department faculty concerned.
- The Head of the Department may identify a faculty member as coordinator for the course. A committee consisting of the Head of the Department, faculty handling the course (if available), coordinator and a senior faculty member nominated by the Head of the Department shall monitor the evaluation process.
- The marks will be awarded to the candidate by the above committee based on their performance.
- The grades earnedby the candidates for the one credit courses which is not opted for conversion into an elective(s), will not be included in the computation of CGPA.

12. INDUSTRIAL TRAINING/ INTERNSHIP

- If Industrial Training is not prescribed in the curriculum, the student may undergo Industrial Training optionally and the credits earned will be indicated in the Grade Sheet
- In case of Internship the training needs to be undergone continuously from one organization only.
- The student is allowed to undergo a maximum of 6 weeks Industrial Training for Internship during the entire duration of study.
- At the end of the Internship training the candidate should submit the report and certificate from the organization where he / she underwent the training.
- Evaluation of the Industrial/Internship training will be done based on the report and Viva-Voce examination conducted internally by a department committee constituted by the Head of the department.
- The college shall monitor the student internship program. The internship report of each student shall be submitted to the Head of the Department of the college with the approval of the Guide.

Duration of Training	Credits
2/3 Weeks	1
6 Weeks	2

13. TRANSFER OF CREDITS THROUGH ONLINE COURSES

Within the broad frame work of the SREC learning outcome based curriculum frame work through choice based credit system Regulations 2020, and on the recommendation of the concerned Chair Person of the Board of studies and the Chair person of the Academic Council, students may be permitted to earn part of the credit requirements for professional and open elective courses from other approved Institutes of repute and status in the country /abroad or online learning courses of SWAYAM* platform under UGC during their period of study(*Credit Frame work for online learning courses through SWAYAM Regulation 2016).

The Credits earned by such credit transferred courses shall be for Professional and Open electives courses only.

THE GUIDELINES FOR THE TRANSFER OF CREDITS ARE AS FOLLOWS:

- The Online Course shall be a credited course which is taught for at least one semester as a part of a subject.
- Students with consistent academic performance (having a CGPA of 8.0 or above and no arrear) can opt for credit transfer courses through online mode of learning with recommendation of the Chairperson of the Board of studies and the approval of the Chair Person of Academic Council.
- The Board of studies of the concerned department shall evaluate the credit transfer course with respect to the course contents, number of contact hours, course evaluation system, and approval or acceptance letter from the other institutions/Online courses and decide the Equivalent Elective Course(s) in their respective department curriculum and the number of Equivalent Credits the student earns for the course
- The Chair person of the Board of studies shall also evolve a method for calculating the Equivalent Grades for the credit transferred courses as per the SREC Autonomous Regulations 2020 by taking into account the course evaluation system followed in the other institution/Online course platform.
- The Chair person of the Board of studies shall issue a Credit Transfer Certificate mentioning in it the details of Equivalent Courses, corresponding Credits and Equivalent Grades for the credit transferred courses. The complete details will then be forwarded to the Chairperson Academic Council for approval.
- Credits and the Grades earned by the student under this Credits Transfer scheme will be reflected in the corresponding Semester Grade Card and Consolidated Grade Card issued by institution by entering the Equivalent Grades for the credit transferred courses.
- Evaluation of online course as per the absolute grading norms is as given below:

Marks	Letter Grade	Grade Point
90-100	O	10
75-89	A+	9
60-74	A	8
50-59	B+	7
40-49	B	6

14. B.E./B.TECH WITH HONOURS/ DEGREE WITH A MINOR

- All branches of Engineering and Technology shall offer Elective Courses in the EMERGING AREAS like Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Robotics, Quantum Computing, Data Sciences, Cyber Security, 3D Printing and Design, Augmented Reality/ Virtual Reality (AR/VR).
- Under Graduate Degree programme in EMERGING AREAS shall be allowed as specialization from the same Department.
- Minor specialization in EMERGING AREAS in Under Graduate Degree programme may be allowed, where a student is from another Department.
- The students eligibility for taking up specialization/Minor degree courses will be the same as that of Directed Self study **(as in S.N.8)** as prescribed in the Revised Regulation Handbook 2020.

- The Additional Number of Credits to be earned for the award of specialization/Minor degree is 20 credits over and above the credits required for the award of Undergraduate degree as suggested in the Model Curriculum. These credits earned for specialization/Minor degree cannot be transferred for the academic credits to be earned for the award of degree.
- The candidate will be permitted to take up specialization/minor degree courses from the IV/V semester onwards. The eligibility criteria will be the (N-1)th semester performance.
- The same candidate will be permitted to undertake both specialization and minor degree courses if the candidate is able to earn the required number of credits for the award of the same.
- The course requirements for specialization/Minor degree are to be completed before the commencement of the final semester of study.

S. No	Under Graduate Engineering Programme	Name of the Specialization / Minor Degree	Permitted to Offer
1	Mechanical Engineering	Robotics	Specialization
2	Electrical & Electronics Engineering	Electric Vehicles	Specialization
3	Electronics & Communication Engineering	Internet of Things (IoT)	Specialization / Minor
4	Electronics & Instrumentation Engineering	Sensors Technology	Specialization / Minor
5	Computer Science & Engineering	Artificial Intelligence and Machine Learning	Specialization / Minor
		Cyber Security	Specialization
		Data Science	Minor
		Virtual & Augmented Reality	Specialization
6	Civil Engineering	Green Technology and Sustainability cEngineering	Specialization

15. GAP YEAR -CONCEPT OF STUDENT ENTREPRENEURSHIP

- The committee with the Principal as the chairman, an external member (preferably from industry), two internal members and respective HODs as the member secretary will evaluate the students who are involved in entrepreneurship activities
- The committee is vested with the power to ascertain the modalities and parameters to recognize a specific student as "Outstanding" for granting gap period for the purpose of pursuing entrepreneurship (or) working on "Startup Idea" at the college level
- First class with distinction will be awarded to those students who availed themselves of gap year facility to pursue entrepreneurship subject to fulfillment of all conditions stipulated in academic regulations for the award of first class with distinction.
- Candidates can pursue entrepreneurship during their programme of study with a break of one year
- The gap year facility is given to ensure syllabus continuity at the time of joining back and after an appraisal process by an incubator where the student is attached.

- Student entrepreneurs working on a start-up idea during gap year of the college may be permitted to convert their start-up project as their final year project towards degree completion
- A GAP year is permitted to the students to take a year break to work on their start-ups and resume academics to complete the course.
- The GAP year ranges from 8 months to a maximum of period of one year.
- The student who is interested to avail for GAP year, shall apply the same after the publication of the results of IV/VI semester.

Eligibility Criteria:

- The student applying for GAP year should have secured a first class
- The student must have participated / won prizes in the national level contests organized by Govt. agencies such as UGC, AICTE, MHRD, DRDO, etc.,/ leading corporates / Institution of Eminence (IITs/IIM/ IISC/NITs, etc.,) Institutional seed funding for Proof of Concept (PoC) setup.
- The student must submit a basic PoC with a minimal validation along with his application.
- A review committee will be constituted comprising of Principal - Convenor, HOD of the Student Department, Internal Members from SREC CoIN, NISP and EDC.
- The decision will be taken by the committee as per the rubrics tabulated below

Hackathons (Max.25)		**MHRD IIC/EDC (Max.25)**		**Funding (Max.10)**	
Phase	**Points**	**Phase**	**Points**	**Phase**	**Points**
Won	10	Won	5	Applied	2
Final Round	10	Participation	5		
Participation	5	Ideation (In -house through MHRD -IIC)	5	Fund received	8
		B-Plan	10		

- Monthly Review will be conducted for the first six months. For the next six months, review will be conducted once in 45 working days.
- At the end of the Gap Year the student must have converted his/her idea into a new product and ensure the validity for Commercialization/Technology Transfer.
- The student can be allowed to avail Gap Year in the Third/Fourth year of his/her study.
- If III Year is availed as Gap Year by the student, he/she may be permitted to sit with the juniors to study the Third Year Courses and take the Final Year (Fourth Year) courses as Self - Study.
- If IV Year is availed, he/she may be permitted to complete the Fourth Year Courses as Self - Study during the III Year itself.
- First class with distinction will be awarded to those students (if eligible) who availed themselves of gap year facility to pursue entrepreneurship subject to fulfillment of all conditions stipulated in academic regulations.
- The student entrepreneurs working on a start-up idea during gap year of the college may be permitted to convert their start-up project as their final year project towards degree completion.

16. LIVE-IN-LAB

- It is an experiential learning programme for the students to understand the problems of the population living in villages and to identify projects to address the problems, develop solutions, put into practice, assess results and ultimately reveal innovative multidisciplinary solutions for the betterment of rural people and rural economy.
- The interested students shall go to the village adopted by the institution from the second year onwards, and they have to stay at least for two weeks continuously in that village.
- During the stay, they can interact with the village population and identify the problem. Further, they have to provide a solution to the problems identified at the end of the period of study to consider the same as an internship.
- COIN and Head of the department should ensure that all the necessary arrangements are made in this regard.
- At the end of the study, the students have to submit a report as a group consisting of maximum of 6 members to the department about the visit which includes the date of visit, questionnaires prepared for the identification of problem, justification and the suggestions/solutions given for the identified problem. Photo proof is essential for all activities.
- The report will be evaluated by a committee constituted by the controller with the approval of the Principal as per the procedure formulated for the evaluation of the project.
- All such projects will be considered as Internship.

ASSESSMENT FOR LIVE - IN - LAB

Review I

Assessment	Marks
Workshop (Group Participation) -Training	15
Village Visit- Reports	15
Problem Identification and Ideation	35
Poster Presentation	10
Paper Submission review/Report	25
Total	100

Review II

Assessment	Marks
Proposed Implementation with COIN - SREC Presentation	10
Proposal Submission + Review	10
Prototype Design	20
Implementation	35
Final Report and Proof of Concept	25
Research Paper Publications/ Product	10
Total	100 + 10

17. STUDENT EXCHANGE SCHEME IN APPROVED FOREIGN UNIVERSITIES

- Students who complete a part of the academic programme either one or two semesters under the student exchange scheme in approved foreign Universities, the transfer of credits of equivalent courses completed by them in the foreign university will be approved;
- The remaining courses of the respective semester(s) which they have not studied in the respective regulation, they shall register for those courses within the next two or subsequent semesters on a self-study basis.
- Such an appearance of the student in those courses will be treated as first appearance for the purpose of classification

18. REAPPEARANCE REGISTRATION

- The maximum number of credits the candidate can register in particular semester cannot exceed 36 credits excluding laboratory courses.
- Choice of reappearance course in registration will be permitted only for candidates who have more than 36 credits excluding practical courses in the current semester of study. A candidate who has to register for less than 36 credits excluding practical courses during the current semester of study shall appear for all courses.
- If a candidate who fails to secure a pass/ is absent for the end semester examination in a theory course (except electives), the student shall do reappearance registration for that course in the subsequent semester/when offered next.
- If a candidate is prevented from writing end semester examination of a course due to lack of attendance the candidate has to register for the course again in the subsequent semester/when offered next, attend the classes and fulfill the attendance requirements and earn continuous assessment marks
- If the course, in which the student has failed/prevented from writing end semester examination due to lack of attendance, is a **professional elective or an open elective,** the student may be permitted to do reappearance registration for that course in the subsequent semester. **(OR)** Register for any **other professional elective or open elective course** in the subsequent semesters, attend the classes and fulfill the attendance and continuous assessment requirements.
- A student who after having earned necessary attendance, has failed in any other course like Laboratory Course, In plant Training, Internship with Continuous Assessment and End semester examination components or in any course carrying only Continuous Assessment marks will register for the examinations when it is conducted next time and will be solely assessed in the final examinations carrying the entire marks of that course.
- A student who has earned necessary attendance in the course Project work/Mini Project but does not submit the report on Project work on or before the date specified by the department/college /whose project report is not accepted for reasons of incompleteness or other serious deficiencies/ could not appear for the semester end examination on the scheduled date, or failed to secure a pass he/she shall be deemed to have failed in the Project work and awarded grade RA and will have to register for the same at the beginning of the subsequent semester, redo and submit the Mini Project/project report at the end of that semester and appear for the final examination, the Continuous Assessment mark earned afresh.
- A student after registering for a course may withdraw his / her registration between first &second Continuous assessment Test on valid reasons and complete the registration process if it is duly authorized by the Faculty Advisor. Total number of **credits** of such dropping courses **cannot exceed 6.**

19. ATTENDENCE REQUIREMENTS FOR APPEARING FOR THE SEMESTER END EXAMINATION OF A COURSE

A candidate who has fulfilled the following conditions shall be deemed to have satisfied the attendance requirements for the completion of a semester:

- Every candidate is expected to attend all classes and secure 100% attendance.
- Candidates who secure, less than 65% of overall attendance will not be permitted to appear for the End Semester Examinations. The Candidate shall seek readmission to the same semester in the subsequent academic year
- A candidate must secure not less than 75% of attendance (after rounding off to the nearest integer) course wise taking into account the total number of periods required for that course as specified in the curriculum.
- The maximum limit of duty leave exemption to a candidate during a semester shall be limited to 10% of the required attendance in that course. This duty leave is for representation in University/Inter University/ State / National/ sports events, Co-Curricular activities, paper and/or project presentation with prior permission from the head of Institution based on the recommendation of the Head of the Department, provided the progress and conduct of the candidate is satisfactory.
- If a candidate secures attendance between 65% and 75% in any course in the current semester due to medical reasons (hospitalization/accident/specific illness) he/she may be given exemption (due to medical reasons only) to appear for the current semester examinations in that course. Subject to the condition that the candidate should submit, the medical certificate approved by the Head of the Institution based on there commendation of the Head of the Department on the day of resuming to college, after availing leave on medical reason.
- Candidates who secures, less than 65% of attendance will not be permitted to appear for the Semester End Examinations of that course. The candidate has to re register and repeat that course in the subsequent semester/ when offered next.
- Students maintaining a CGPA $\geq$ 9.00 and SGPA $\geq$ 9.00 in the latest completed semester can avail a waiver for attendance in the following semester. Students who avails the attendance waiver will be awarded the marks based on their performance in an advanced assignment specified by the course coordinator (in emerging topics related to the course).
- She/He can appear in all assessments and evaluation components without being marked ineligible due to attendance-based regulations
- Students participating in National/International events like Hackathon, Innovation contest etc., will be condoned for 9 instructional days per semester, and in Entrepreneurship related activities a maximum of 18 instructional days per semester.

20. ASSESSMENT PROCEDURES FOR AWARDING MARKS

- All B.E../B.Tech. Programmes consist of Theory Courses, Laboratory Courses, Theory integrated with laboratory and Employability Enhancement Courses.
- Appearance in Semester End Examination is mandatory for all courses including Theory, Laboratory and Project work.
- Performance in each course of study shall be evaluated based on
    - Continuous assessments throughout the semester
    - Semester End Examination at the end of the semester

20.1 MARKS WEIGHTAGE FOR DIFFERENT COURSES:

S.No	Category of course	Continuous Assessments Marks	Semester End Examinations Marks
1	Theory Courses	40	60
2	Laboratory Courses	60	40
3	Projects Work	60	40
4	Theory cum Laboratory Courses	50	50
5	All Other Courses	100	

- The Semester End Examinations for theory courses will be of 3 hours duration and shall normally be conducted between October and December during the odd semesters and between April and June during the even semesters.
- Semester End Examination is a mandatory requirement for passing the course having an external component and every candidate should appear for the examination for theory, laboratory courses and project work.
- In case a student is unable to attend the continuous assessment due to medical reasons (hospitalization / accident/ specific illness) or due to participation in the College / University / State / National / Sports events with prior permission from the Head of the Department a Reassessment may be given at the end of the semester after getting approval from the Head of the Department through the concerned course instructor events with prior permission from the Head of the Department a Reassessment may be given at the end of the semester after getting approval from the Head of the Department through the concerned course instructor

20.2 CONTINUOUS ASSESSMENT FOR THEORY COURSE

Assessment	Continuous Assessment weightage 40%		End Semester Examinations weightage 60%
	Duration	Weightage	
Semester in Exam - I	120 min	12.5	
Semester in Exam - II	120 min	12.5	
Assessment by Course instructor (A1)	-----	5	
Assessment by Course instructor (A2)	------	5	
Assessment by Course instructor (A3)	------	5	

20.3 CONTINUOUS ASSESSMENT FOR LABORATORY COURSES:

Assessment	Continuous Assessment weightage 60%		End Semester Practical Examinations40%		
	Duration	Weightage			
Semester in Exam - I	90 min	20	Exam	Pre Examination Viva	10
Semester in Exam - II	90 min	20		Exercise	20
				Record	10
Lab Weekly Exercise	-----	10	PLUS	Paper Publications 5 marks	
Mini / Capstone Project	------	10			

- The Semester End Examinations for Laboratory courses shall normally be conducted between October and December during the odd semesters and between April and June during the even semesters.
- Every laboratory exercise / experiment should be evaluated based on the candidate's performance during the laboratory class /examination and the student's records maintained.

20.4 ASSESSMENT FOR THEORY CUM LABORATORY COURSES

Component	Assessment	Continuous Assessment weightage 50%		End semester examination weightage 50%		
		Duration	Weightage	Assessment		Weightage
LAB	Exam Cycle - I	90 min	10	Lab Examination	Viva	5
	Lab Weekly Exercise		5		Experiment	10
Theory	Semester in Exam - I	120 min	12.5	End Semester Exam Theory	3 Hrs	35
	Semester in Exam - II	120min	12.5			
	Assessment by Course instructor (A1)	------	5			
	Assessment by Course instructor (A2)	-------	5			

20.5 ASSESSMENT FOR MINI PROJECT / PROJECTWORK

- Project work may be assigned to a single candidate or a group of candidates not exceeding 3 per group.
- There shall be two assessments during the semester by are view committee. The student shall make presentation on the progress made before the committee.
- The Head of the Department shall constitute a project review committee for each programme.
- The project evaluation shall be carried out by a project committee comprising Head of the Department or his/her Nominee (Chairperson), Project Coordinator, (Prof/Assoc.Prof) and Project Faculty Guide.
- The project work assessment shall be based on:
- Conceptual understanding of Engineering Fundamentals
- Ability to design and develop solution and conduct investigation of complex problems
- Ability touse modern engineering and IT tools
- Decision making ability
- Interdisciplinary approach
- Initiative, leadership, and sense of responsibility
- Ability to produce research information for team
- Ability to demonstrate under standing of team rules when assigned, share in teamwork
- Ability to demonstrate good communication skills
- Completion of objectives
- Presentation
- Answer to queries
- The candidate(s) is expected to submit the project report on or before the last working day of the semester.
- The semester end examination for project work shall consist of evaluation of the final project report submitted by the candidate or students of the project group by an external examiner followed by a viva-voce examination conducted separately for each student by a committee consisting of the external examiner, the guide of the project group and an internal examiner

Continuous Assessment weightage 60%		End semester examination weightage 40%	
Components	**Weightage**	**Components**	**Weightage**
Review I	**15**	**Presentation**	**10**
Review II	**15**	**External Review**	**10**
Review III	**15**	**Report**	**10**
Report Review by Guide	**15**	**Paper Publication**	**10**

Ethics & Academic Integrity Requirements of Mini Project /Project work

Criteria for accepting similarity index (using turn it in plagiarism check software), for the submission of UG Mini project / project work report

- The overall similarity index should not exceed 25% to be acceptable
- The highest similarity percentage from any one source should not exceed 4-6%.
- In case of self-plagiarism, the permissible percentage should not exceed, say at 7-10%.

20.6 ASSESSMENT OF CONTINOUS ASSESSMENT COURSES

	Internal 100%	
Type of Course	**Components**	**Weightage**
ONE-CREDIT COURSE	Quiz/ Assignment	25
	Test I	75
INDUSTRIAL TRAINING/ INTERNSHIP	Assessment by Industry	30
	Viva-voce	20
	Case Study / Report	20
	Presentation	30
SEMINAR	Seminar Paper / Report	40
	Presentation	40
	Answer to Queries	20

21. PASSING REQUIREMENTS

A candidate must who has obtained **minimum of 45% marks in the end semester examination, in both Theory and Practical Courses** (including Project work), **is declared to have passed in the end semester examination for that course.**

A candidate who secures not less than 50% (Internal Assessment + End semester examinations marks) is declared to have passed in the examination for that course

A student is deemed to have passed in any course carrying only Continuous Assessment marks if the total mark secured by him/her **is at least 50% of total marks.**

A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

22. AWARD O FLETTER GRADES

- All assessments of a Course will be done on Relative Grading System
- The same Ranges of Grades are applicable for the results of revaluation/Re appeaance / substitute / supplementary examinations of that particular course.
- Relative Grading System: In the system, the grades are awarded to the students based on their performance relative to others in Theory and theory cum laboratory courses having Continuous Assessment (CA) and end semester Examination (SE) components.
- Uniform Evaluation Method of students based on Relative Grading as issued by Registrar and Controller of Examinations office Anna University, Chennai through circular Letter No.4041/AU/CAC/Rel.Grading/2022 dated 25.06.2022 and Letter No. 793/AU/CAC/2022 dated 17.02.22 is followed for the awarding of Grades.
- This uniform evaluation method consists of the norms to be followed for the award of marks for internal and end semester examinations of all types of courses ,passing requirements ,relative grading and award of letter grades and classification of degree of degree.
- This is followed for the evaluation and passing of results for all the UG/PG students who joined from the academic year 2021-2022 onwards in Autonomous Colleges affiliated to Anna University.
- The process of Grade generation the steps of Moderation, Normalization, Separation of Passed and Failed marks and then Grade Generation using the Anna University Relative Grading system(AURG).
- All candidates with failed marks will be awarded U Grade
- There will be six letter Grades for the passed candidates such as O,A+,A,B+,B, AND C

Letter Grade	Description	Grade Points
O	Excellent	10
A+	Very Good	9
A	Good	8
B+	Above average	7
B	Average	6
C	Pass	5
U	denotes Re-appearance for not scoring the minimum passing requirement	0
RA SA	denotes Re-appearance for the examination due to Shortage of Attendance	
RA-AB	Denotes Re-appearance for being absent for the examination	
WH	Denotes withdrawal in the End Semester Examination	

23. GPA AND CGPA CALCULATION

All assessments of a course will be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying certain number of points, will be awarded as per the range of total marks (out of 100) obtained by the candidate in each course.

After the results are declared, grade sheets will be issued to each student, which will contain the following details:

- The list of courses enrolled during the semester and the grades scored.
- The Grade Point Average(GPA) for the semester, which is calculated as follows:

$$GPA = \frac{\sum_{i=1}^{n}(C_i \times GP_i)}{\sum_i C_i}$$

The Cumulative Grade Point Average(CGPA), which is calculated as follows:

$$CGPA = \frac{\sum_{j=1}^{n}(C_j \times GP_j)}{\sum_j C_j}$$

Where C_i/ C_j- is the credits assigned to the course

GP_i, GP_j - is the grade point corresponding to the letter grade obtained for each course

n - is number of all courses successfully cleared during the particular semester in the case of GPA and during all the semesters in the case of CGPA.

24. ELIGIBILITY FOR THE AWARD OF DEGREE

A student shall be declared eligible for the award of the Degree if he/she has

- Successfully gained the required number of total credits as specified in the curriculum corresponding to his/her programme of study within the stipulated time.
- Successfully completed the prescribed number of Value Added Courses*, and essential non-academic courses if prescribed in the regulations.
- Successfully completed any additional course prescribed by the Head of the Institution, whenever the candidate is readmitted under their regulations.
- No disciplinary action is pending against him/her.

*Value added course (if any) are offered to facilitate the students to keep pace with the latest technologies pertaining to their chosen field of study. The students have the option to choose the course according to their interest and these courses will improve the employability of the students and assist them in exploring new opportunities.

25. CLASSIFICATION OF THE DEGREE AWARDED

a. FIRST CLASS WITH DISTINCTION

A student who satisfies the following conditions shall be declared to have passed the examination in **First class with Distinction:**

- A candidate who qualifies for the award of the Degree having passed the examination in all the courses prescribed for the programme of study with in the **stipulated number of Semester of study in first appearance plus one year (Two Semesters)** which includes authorized break of study of one year (if availed).
- The candidate should have secured a **CGPA of not less than 8.50** in all the courses prescribed for the programme of study.
- The candidate should NOT have been prevented from writing semester end examination due to lack of attendance in any of the courses.

b. FIRST CLASS

A student who satisfies the following conditions shall be declared to have passed the examination in First class:

- A candidate who qualifies for the award of the Degree having passed the examination in all the courses prescribed for the programme of study with in the **stipulated number of semesters plus one year (Two Semesters)** reckoned from the commencement of study in the first Semester including authorized break of study (if availed) (or) Prevention from writing semester end examination due to lack of attendance (if applicable)
- The candidate should have secured a **CGPA of not less than 6.50** in all the courses prescribed for the programme of study.

c. SECOND CLASS

- All other candidates (not covered in **clause 25.a and 25.b**) who qualify for the award of the Degree shall be declared to have passed the Examination in Second Class.

26. RANK

- A student shall be eligible for award of ranking only if he/she has passed the examination in **First class with distinction or First class in having passed all the courses in first attempt.**
- Those who have availed the provision of break of study / withdrawal will not be eligible for rank.
- Ranks will be awarded only for a maximum of 5% the Class strength

27. PROCEDURE FOR COMPLETING THE COURSE

- The academic year will be from June to May in which odd semester will be from the period of June to November / December and even semester from December to May / June respectively.
- A candidate who has a break of study for some reason in any one of the semesters in the degree of study can rejoin the course in that semester only at the time of its normal commencement in the Institution for regular students upon satisfying the following conditions:
- He/She should have obtained the approval from the DOTE and Affiliating University
- He /She should have completed the courses of study of the previous semesters.
- He/She should have registered/appeared for all the Examinations of the previous semesters.
- A candidate will be permitted to proceed from one semester to the next Semester only if he / she has satisfied the regulation for eligibility to appear for the Semester End Examination in the semester concerned.
- It is mandatory that a candidate has to complete the required number of value added courses during the duration of the programme.

  It is mandatory to successfully complete the required Employability Enhancement Course /other Mandatory courses during the duration of the programme.
- No candidate will be enrolled in more than one Semester at any time. In the case of repeaters / Readmission, the earlier Internal Assessment in the respective courses will be disregarded.

28. END SEMESTER EXAMINATIONS

- There shall be an Semester End Examinations of 3 hours duration in each lecture/tutorial based courses.

- The Semester End Examinations shall be conducted between October and December / January during the Odd semesters and between March and May/June in the Even Semesters.
- If a student indulges in malpractice during examinations, the student shall be liable for punitive action as prescribed by the University from time to time.
- A candidate who is absent for semester examination in a Course/Project Work after having enrolled for the same shall be considered to have attempted in that examination for the purpose of classification.
- Supplementary Examinations may also be conducted at such times as may be decided by the Chairperson of the Academic Council/Principal subject to the approval of the Academic Council.
- After the duration of the programme (stipulated number of semesters) the passing requirement in the Semester End Examinations will be 50% marks in the Semester End Examination for that course.

29. TRANSPARENCY IN EVALUATION

- After the publication of End Semester results, the students are allowed to verify the answer scripts of all subjects as per approved norms
- Consequently, the application for revaluation of the answer scripts for those subjects is permitted.
- The refund of the fee will be made for the candidate who has failed originally and secured a pass mark after the revaluation of the answer script
- The verification of answer scripts is not allowed for practical courses, one credit courses, seminars, practical training and project work.

30. REVALUATION & REVIEW

The students are entitled for the following within fifteen days from the declaration of the results.

- As per the regulations, there is only one valuation. However, a candidate after verification of their answer scripts, if is not satisfied with the Grades allotted. Then they can apply for Revaluation on payment of the prescribed fee. If the student is not satisfied with the Grades allotted after Revaluation, they can apply for **review of answer script.**
- Only a candidate who has applied for the verification of answer script and Revaluation of the answer script is eligible for applying for review of answer script.
- The prescribed fee for the review of answer script should be paid. The refund of the fee will be made for the candidate who has failed originally and secured a pass mark after there view of answer script.

31. ISSUE OF STATEMENT OF GRADES AND DEGREE CERTIFICATE

- After the publication of the results in each semester, the Institution will issue the Statement of Grades. After the successful completion of the Degree Programme, the Academic Council of the Institution will recommend the list of candidates to the University for award of the Degree Certificates.

32. PROVISION FOR WITHDRAWAL FROM EXAMINATION:

- A candidate, may for valid reasons and on prior application, (medically unfit/Unexpected family situations/sports approved by the Head of the Institution) may be granted permission to withdraw from appearing for the Semester End Examinations in any course or courses in **only one semester examinations during the entire duration of the Degree Programme.**

- Withdrawal application shall be valid only if the candidate is eligible to appear for the Examination in that course and if it is made **prior to the commencement of the examination in that course(s)** duly recommended by the Head of Department and approved by the Head of the Institution.
- Withdrawal shall not be construed as an appearance for the eligibility of a candidate for First Class with Distinction.
- The candidate shall reappear for the withdrawn Course / Courses during the Examination conducted in the immediate subsequent Semester. Withdrawal is not permitted in the Semester End Examinations in the final semester of the period of study by the candidate.

33. BREAK OF STUDY FROM A PROGRAMME

- The candidates permitted to rejoin the programme after break of study shall be governed by the Curriculum and Regulations in force at the time of rejoining.
- The students rejoined in any of the Semesters have to gain the stipulated number of credits in order to become eligible for the award of degree, under the regulations in vogue at the time of his/ her rejoining.
- The total period for completion of the programme reckoned from the commencement of the course for the first Semester to which the candidate was admitted shall not exceed the maximum period, irrespective of the period of break of study in order that he/she may be eligible for the award of the Degree.
- If any student is detained for want of required attendance, progress and good conduct, the period spent in that semester shall not be considered as permitted 'Break of Study'.

34. FACULTY ADVISOR AND CLASS COMMITTEE

To help the students in planning their courses of study and for general advice on the Academic Programme, the Head of the Department will attach a certain number of students to a teacher of the Department who shall function as Faculty Advisor for those students throughout their period of study. Such Faculty Advisor shall advise the students and monitor the courses taken by the students, check the attendance and progress of the students attached to him / her and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress of their wards. An Academic Coordinator will monitor the Faculty Advisors.

The class committee consists of teachers who handle the class, student representatives and a chairperson who is not handling the course for that class. It is like the 'Quality Circle" with the overall goal of improving the teaching-learning process.

The functions of the Class Committee include:

- Solving problems faced by students in the classroom and in the laboratories.
- Clarifying the regulations of the Degree Programme and the details of rules there in.
- Informing the student representatives about the academic schedule dates and the syllabus coverage.
- Informing the student representatives about the regulations regarding weightage used for each assessment.
- In case of Practical Courses (Laboratory /Drawing / Project Work / Seminar etc.) the breakup of marks for each Experiment/exercise/module of works, should be clearly interacted with the representatives In the Class Committee Meeting who would inform the students.
- Analyzing the performance of the students of the class after each Test and finding the ways and means of solving problems, if any.

- Identifying the weak students, if any and requesting the teachers concerned to provide some additional help or guidance or coaching for such weak students.

The Class Committee for a class under a particular programme is constituted by the Head of the Department. The Class Committee shall be constituted in the first week of the Semester. Two or three subsequent meetings may be held at suitable intervals. During these Meetings, the student members representing the entire class, shall meaningfully interact and express their opinions and suggestions of the class students to improve the effectiveness of the teaching-learning process. At least 10 student representatives (including girls) shall be included in the Class Committee.

The Chairperson of the Class Committee may invite the Academic Coordinator, Faculty advisor(s) and the Head of the Department to the meeting of the Class Committee.

The Chairperson has to prepare the minutes of every meeting, submit the same through the Head of the Department to the Head of the Institution with in two days of the Class Committee meeting and arrange to circulate among the students and teachers concerned. If there are some points in the minutes, requiring action by the authorities concerned, the same shall be brought to the notice of the authority by the Head of the Institution.

35. MANDATORY COURSES (MAC)

- These courses include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc.
- All students shall enroll, for atleast one course from Personality and Character Development category and one course from Allied Skills category listed below in addition to mandatory employment enhancement courses/department allied courses prescribed in the curriculum of the programme concerned for the award of degree

Table of Mandatory Courses

Category	Course Title	
Personality and Character Development	Sports & Games	Any one Course
	Empowerment through Yoga	
	National Cadet Corps	
	National Service scheme	
	Extra/Co Curricular Activities	
	Professional Society Activities	
	Aptitude/Soft skills	
	Youth Red Cross	
Allied Skills	English Proficiency Certification	Any one Course
	Foreign / Vernacular Languages	
	Globally accepted Technical Certification Courses	
• Courses offered Career Development and Placement Division • Courses offered by Bureau of Overseas Education • Courses offered by entrepreneurship development cell		Any one Course

36. Universal Human Values and Professional Ethics Course

- A course on Universal Human Values and Professional Ethics is mandatory to all the candidates of the various B.E. /B.Tech programmes as per the recommendations of AICTE (Except B.E. Bio Medical Engineering)
- The content will be delivered as three, fifteen hour courses.
- The first two contents of fifteen hour course will be common to all Programmes of B.E./B.Tech and in continuation to the Universal Human Values delivered during the first year Induction Programme.
- The third fifteen hour content is to be programme specific and to be delivered by the specific departments.
- It is essential to complete the Universal Human values and Professional Ethics course by all the candidates of B.E./B.Tech programmes.

37. DISCIPLINE

Every student has to maintain discipline both inside and outside the Institution and not to indulge in any activity that may spoil the name of the Institution. The Head of the Institution shall constitute a Disciplinary Committee which will enquire into act so find discipline and report to the Head of the Institution.

38. REVISION OF REGULATIONS, CURRICULUM AND SYLLABI

The Institution may from time to time revise, amend or change the regulations, scheme of examinations and syllabi if found necessary through the approval of the Academic Council with the approval of the affiliating University.

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

DEPARTMENT OF MECHANICAL ENGINEERING

The department of Mechanical Engineering established in the year 1994, offers B.E. (Mechanical Engineering) and M.E. (Manufacturing Engineering) program and is permanently affiliated to Anna University, Chennai. It is also recognized research department by Anna University, Chennai offering Ph.D program. The Undergraduate program was accredited in the year 2003,and reaccredited in 2007, 2012 and 2015 by NBA, New Delhi.

VISION AND MISSION OF THE DEPARTMENT

VISION

- The Department of Mechanical Engineering excels in Engineering Education and building enterprising professionals, encompassing creativity, innovation, research, employability and entrepreneurship, meeting the requirements of the society.

MISSION

- To provide quality engineering education that equips the students with adequate knowledge in mechanical engineering to become successful professionals.
- To prepare the students with effective communication skills, intellectual abilities, teamwork and professional ethics for valuable contribution to the society.
- To facilitate the students in orienting towards research and life-long learning to meet the needs of the stakeholders.

Programme Educational Objectives (PEOs)

The graduates of this program, after four to five years, will

PEO1: Offer rationale solutions in designing and manufacturing of mechanical as well as allied engineering systems through the acquired knowledge in Mathematics, Physical Science, Engineering and Technology.

PEO2: Demonstrate the professional and entrepreneurial skills with confidence to seek solutions to the tasks with due consideration on social, environmental, economical and ethical values.

PEO3: Communicate effectively and engage in life-long learning for professional and personal growth.

Program Outcomes and Program Specific Outcomes (POs and PSOs)

Program Outcomes as stated by NBA: Engineering Graduates will be able to

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes:

Mechanical Engineering students at the time of graduation will be able to

PSO1: Design, model and analyze mechanical components and systems using computational engineering tools.

PSO2: Plan the manufacturing processes of mechanical components and systems corisidering quality, cost and safety.

PSO3: Identify and evaluate the thermal and heat transfer properties of mechanical systems.

CURRICULUM AND SYLLABUS FOR

HUMANITIES AND SOCIAL SCIENCES (HS)

BASIC SCIENCES (BS)

ENGINEERING SCIENCES (ES)

OPEN ELECTIVES (OEs)

ONE CREDIT COURSES(OCs)

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS COURSES

MANDATORY COURSES

ENLIGHTENMENT THROUGH EDUCATION
SREC

CURRICULUM

S. No.	Course Code	Course Title	L	T	P	C	POs	CA	ES	TOTAL
HUMANITIES AND SOCIAL SCIENCES (HS)										
1.	20AE201	Liberal Arts - Indian Space Missions	1	0	0	1	5, 6	100	-	100
2.	20AE203	Aviation Management	3	0	0	3	1, 8, 11	40	60	100
3.	20BM207	Hospital System Management	2	0	0	2	6,7,8,9,11	40	60	100
4.	20BM208	Regulatory affairs, Bioethics and Intellectual Property Rights	2	0	0	2	6,7,8	40	60	100
5.	20CE206	Liberal Arts -Architectural Conservation and Historic Preservation	1	0	0	1	1,2,6,7	100	-	100
6.	20CE207	Liberal Arts -Cultural Implications on Building Design	1	0	0	1	1,3,6,9	100	-	100
7.	20CE224	Circular Economy for Sustainable Built Environment	1	0	0	1	2,5,7	100	-	100
8.	20CE225	Principles of Construction Management	3	0	0	3	1,2,5,10,11	40	60	100
9.	20CE226	Lean Construction Technology	3	0	0	3	1,2,5,7,11	40	60	100
10.	20CS203	Liberal Arts - Sociology of Digital Media	1	-	-	1	1, 2, 3, 6, 7, 8, 9, 10, 12	100	-	100
11.	20CS231	Entrepreneurship Development And Business Management	3	-	-	3	2,3,5,6,7,9, 10,11,12,	100	-	100
12.	20CS232	Management Essentials For Engineers	3	-	-	3	1,2,3,11	100	-	100
13.	20CS233	Workplace Professionalism And Human Values	3	-	-	3	6,7,8,12,	100	-	100
14.	20EE209	Principles of Management	2	0	0	2	6, 8, 9, 11, 12	40	60	100
15.	20EE210	Total Quality Management	2	0	0	2	1,6,7, 9, 10, 12	40	60	100
16.	20EE216	Project and Finance Management	2	0	0	2	8, 9, 11, 12	40	60	100
17.	20EE235	Positive Psychology	1	0	0	1	6, 10, 12	100	-	100
18.	20EI210	Engineering Project and Finance Management	3	0	0	3	9, 10, 11, 12	40	60	100
19.	20EI211	Planning and Organizational Behavior	3	0	0	3	8, 9, 10, 12	40	60	100
20.	20EI219	Leadership Excellence and Development	1	0	0	1	9,10,11,12	100	-	100
21.	20HS201	Advanced Business English	3	0	0	3	9, 10, 12	100	-	100
22.	20HS202	Technical Writing	3	0	0	3	9, 10, 12	100	-	100
23.	20HS203	Basic German	3	0	0	3	9, 10, 12	100	-	100

24.	20HS204	Basic Japanese	3	0	0	3	9, 10, 12	100	-	100
25.	20HS270	Preliminary Business English	2	0	2	3	9, 10, 12	100	-	100
26.	20IT209	Entrepreneurship Development	3	0	0	3	2,3,4,7,12	40	60	100
27.	20IT210	Project Management	3	0	0	3	2,3,4,5,9,12	40	60	100
28.	20IT203	Web Design	1	0	0	1	1,2,3,5,12	100	-	100
29.	20IT218	Liberal Arts - Women Development and Empowerment	1	0	0	1	8,12	100	-	100
30.	20MA209	Liberal Arts Vedic Mathematics	1	0	0	1	1,2	100	--	100
31.	20ME218	Total Quality Management	2	0	0	2	1,2,6,7,11,12	40	60	100
32.	20ME225	Economics for Engineers	3	0	0	3	1,2,4,11,12	40	60	100
33.	20RA212	Work System Engineering and Ethics	3	0	0	3	1,6,7	40	60	100
34.	20RA217	Economics for Robotics and Automation	3	0	0	3	1,7	40	60	100

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

BASIC SCIENCES (BS)										
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**POs**	**CA**	**ES**	**TOTAL**
1.	20AEI01	Design Thinking	1	0	0	1	1, 2, 3, 4, 5, 10	100	-	100
2.	20AE271	Computing Laboratory	0	0	2	1	1, 2, 3, 5, 9, 10, 12	60	40	100
3.	20BM201	Biochemistry	3	0	0	3	1	40	60	100
4.	20BM203	Human Anatomy and Physiology	3	0	0	3	1	40	60	100
5.	20BM205	Life Science	2	0	0	2	1	100	-	100
6.	20BM206	Biology for Engineers	1	0	0	1	1	100	-	100
7.	20BM217	Concepts of Medical Device Design	2	0	0	2	1,3,5	40	60	100
8.	20BM270	Biochemistry Laboratory	0	0	2	1	1	60	40	100
9.	20BM271	Human Anatomy & Physiology Laboratory	0	0	2	1	1	60	40	100
10.	20BS201	Physical Sciences	4	0	0	4	1	40	60	100
11.	20BS270	Basic Sciences Laboratory	0	0	2	1	1,2,5,9,10,12	60	40	100
12.	20CE201	Basics of Geology	1	0	0	1	1,7	40	60	100
13.	20CE202	Principles of Architecture and Planning Concepts	2	0	0	2	1,5,9	40	60	100
14.	20CE208	Applied Geology	1	0	0	1	1,2,6,7	100	-	100
15.	20CE218	Landscaping and Interior Design	2	0	0	2	1,2,5	40	60	100
16.	20CH208	Materials and Composites	3	0	0	3	1,2	40	60	100
17.	20CH209	Chemistry of Advanced Materials	3	0	0	3	1	40	60	100
18.	20CH201	Engineering Chemistry	2	0	0	2	1,2	40	60	100
19.	20CH202	Chemical Science	2	0	0	2	1	40	60	100
20.	20CH203	Chemistry	2	0	0	2	1,7	40	60	100
21.	20CH204	Applied Sciences - II	2	0	0	2	1	40	60	100
22.	20CH205	Applied Chemistry	2	0	0	2	1	40	60	100
23.	20CH207	Corrosion Science	3	0	0	3	1,2	40	60	100
24.	20EC203	Electromagnetic Fields	3	0	0	3	1,2,5,12	40	60	100
25.	20EI271	Simulation Laboratory	0	0	2	1	1,2,4,5,9,12	60	40	100
26.	20EI205	Electrical Machines and Drives	3	0	0	3	1,2,3	40	60	100
27.	20IT2I01	Design Thinking	1	0	0	1	1,2,3,5,6,9	100	-	100
28.	20ME203	Design Thinking	1	0	0	1	1,2,3,6,9,10,12	100	-	100
29.	20MA201	Algebra, Calculus and Transforms	3	1	0	4	1, 2, 5, 9	40	60	100
30.	20MA202	Matrices, Differential Calculus and Transforms	2	1	0	3	1, 2, 5, 9	40	60	100
31.	20MA203	Linear Algebra and Differential Calculus	3	1	0	4	1, 2, 5, 9	40	60	100

32.	20MA204	Integral and Vector Calculus	2	1	0	3	1, 2, 5, 9	40	60	100
33.	20MA205	Calculus and Numerical Methods	2	1	0	3	1, 2, 5, 9	40	60	100
34.	20MA206	Transforms and Its Applications	2	1	0	3	1, 2, 5, 9	40	60	100
35.	20MA207	Integral Calculus and Partial Differential Equations	3	1	0	4	1, 2, 5, 9	40	60	100
36.	20MA208	Linear Algebra and Vector Calculus	2	1	0	3	1, 2, 5, 9	40	60	100
37.	20MA210	Partial Differential Equations and Tensor Calculus	2	1	0	3	1,2,5,9	40	60	100
38.	20MA211	Transforms and Partial Differential Equations	2	1	0	3	1,2,5,9	40	60	100
39.	20MA212	Computational Methods in Engineering-I	2	1	0	3	1,2,5,9	40	60	100
40.	20MA213	Numerical Methods	3	1	0	4	1,2,5,9	40	60	100
41.	20MA214	Discrete Structures and Combinatorics	2	1	0	3	1,2,5,9	40	60	100
42.	20MA215	Probability and Statistics	2	1	0	3	1,2,5,9	40	60	100
43.	20MA216	Probability and Queueing Theory	2	1	0	3	1,2,5,9	40	60	100
44.	20MA217	Transforms, Probability and Statistics	2	1	0	3	1,2,5,9	40	60	100
45.	20MA218	Probability, Statistics and Numerical Methods	2	1	0	3	1,2,5,9	40	60	100
46.	20MA219	Probability and Random Processes	2	1	0	3	1,2,5,9	40	60	100
47.	20MA220	Computational Methods In Engineering- II	3	1	0	4	1,2,5,9	40	60	100
48.	20PH201	Engineering Physics	2	0	0	2	1,5,12	40	60	100
49.	20PH202	Waves and Optics	2	0	0	2	1,5	40	60	100
50.	20PH203	Physics	2	0	0	2	1,5	40	60	100
51.	20PH204	Applied Sciences I	2	0	0	2	1,5	40	60	100
52.	20PH205	Applied Physics	2	0	0	2	1,5	40	60	100
53.	20PH206	Biophysics	2	0	0	2	1,5	40	60	100
54.	20PH214	Biophysics	3	0	0	3	1,5	40	60	100
55.	20PH207	Nano and Smart Materials	3	0	0	3	1,5,12	40	60	100
56.	20PH208	Essentials of Materials Science	2	0	0	2	1,5	40	60	100
57	20PH209	Nano and Quantum Physics	3	0	0	3	1,5	40	60	100
58.	20PH210	Essentials of Quantum Physics	3	0	0	3	1,5	40	60	100
59.	20PH211	Advanced Materials	2	0	0	2	1,5	40	60	100
60.	20PH213	Aircraft Materials and Processes	2	0	0	2	1, 2, 3, 7, 12	40	60	100
61	20PH270	Physics Laboratory	0	0	2	1	1,2,5,9,10,12	60	40	100
62.	20MA221	Optimization Techniques	3	1	0	4	1,2,5,9	40	60	100
63.	20MA101	Graph Theory	2	1	0	3	1,2,5,9	40	60	100

ENGINEERING SCIENCES (ES)										
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**POs**	**CA**	**ES**	**TOTAL**
1.	20AE272	Engineering Drawing Practices	0	0	2	1	1, 3, 5, 9, 10, 12	60	40	100
2.	20AE204	Fluid Mechanics and Machinery	2	1	0	3	1, 2, 3, 4	40	60	100
3.	20AE205	Thermodynamics	2	1	0	3	1, 2, 3, 4, 5	40	60	100
4.	20AE273	Mechanical Sciences Laboratory	0	0	2	1	1, 2, 3, 9, 10, 12	60	40	100
5.	20BM202	Frontiers in Biomedical Engineering	2	0	0	2	1, 7	40	60	100
6.	20BM204	Circuits and Devices	3	1	0	4	1	40	60	100
7.	20BM272	Circuits and Devices Laboratory	0	0	2	1	1	60	40	100
8.	20BM213	Principles of Telemedicine and Mobile applications	3	0	0	3	1,5,6	40	60	100
9.	20CE203	Construction materials, Techniques and Equipment	3	0	0	3	1,5,8	40	60	100
10.	20CE204	Geodesy	3	0	0	3	1,2,5	40	60	100
11.	20CE205	Engineering Mechanics	3	0	0	3	1,2	40	60	100
12.	20CE270	Building Planning and Drafting Laboratory	1	0	2	2	1,5,9,10	60	40	100
13.	20CE271	Geodesy Laboratory	0	0	2	1	1,2,3,5,9	60	40	100
14.	20CE272	Material Testing Laboratory	0	0	2	1	1,4,5,10	60	40	100
15.	20CE219	Smart City and Urban Planning	2	0	0	2	1,2,11	40	60	100
16.	20CS201	Disruptive Technologies	2	0	0	2	1,2,3,4,7,12	100	-	100
17.	20CS202	Programming Paradigms - I	2	1	0	3	1,2,3,4,12	40	60	100
18.	20CS241	Programming Foundations	2	0	0	2	1,2,3,4	40	60	100
19.	20CS242	Artificial Intelligence	2	0	0	2	1,2,3,4,12	40	60	100
20.	20CS271	Computer Hardware and Software Laboratory	0	0	2	1	1,2,3,4,5	60	40	100
21.	20CS272	Programming Paradigms - I Laboratory	0	0	2	1	2,3,4,5,12	60	40	100
22.	20CS291	Programming Foundations Laboratory	0	0	2	1	1,2,3,4,5,9,10	60	40	100
23.	20CS204	Programming Paradigms - II	3	0	0	3	1,2,3,4,5,11	40	60	100
24.	20CS273	Programming Paradigms - II Laboratory	0	0	2	1	1,2,3,4,5,11	60	40	100
25.	20CS210	Programming Paradigms - III	3	0	0	3	1,2,3,4,5,	40	60	100
26.	20CS278	Programming Paradigms - III Laboratory	0	0	2	1	1,2,3,4,5	60	40	100
27.	20CS243	Data Structures and Algorithm Analysis	2	0	0	2	1,2,3,4	40	60	100
28.	20CS292	Data Structures and Algorithm Analysis Laboratory	0	0	2	1	1,2,3,4	60	40	100

29.	20EE201	Electric Circuits	3	0	0	3	1,2,5,9,10	40	60	100
30.	20EE236	Principles of Electrical Engineering	3	0	0	3	1,2,5,9,10	40	60	100
31.	20EE237	Foundations of Electrical Engineering	3	0	0	3	1,2,5,6,9,10	40	60	100
32.	20EE251	Compendium of Electrical Engineering	2	0	2	3	1,2,5,9,10	50	50	100
33.	20EE261	Electrical and Electronics Engineering	3	0	2	4	1,2,5,9,10	50	50	100
34.	20EE262	Basics of Electrical and Electronics Engineering	2	0	2	3	1,2,5,9,10	50	50	100
35.	20EE270	Electric Circuits and Electron Devices Laboratory	0	0	2	1	1,2,5,9,10	60	40	100
36.	20EE202	Network Analysis and Synthesis	2	1	0	3	1,2,5,9,10	40	60	100
37.	20EE203	Electromagnetics	2	1	0	3	1,2,5,12	40	60	100
38.	20EE238	Electrical Machines and Power Systems	3	0	0	3	1,2,6	40	60	100
39.	20EC201	Electron Devices	3	0	0	3	1,2,3,5	40	60	100
40.	20EC202	Aircraft Electrical and Electronic Systems	3	0	0	3	1,2,3,5	40	60	100
41.	20EC270	Basic Electrical and Electronics Laboratory	0	0	2	1	1,2,3,5	60	40	100
42.	20EC222	Analog Devices and Integrated Circuits	3	0	0	3	1,2,3,5	40	60	100
43.	20EC290	Analog Devices and Integrated Circuits Laboratory	0	0	2	1	1,2,3,4,5,9, 10,12	60	40	100
44.	20EC223	Digital Circuits and Microcontrollers	3	0	0	3	1,3,4,5, 11 ,12	40	60	100
45.	20EC291	Digital Circuits and Microcontrollers Laboratory	0	0	2	1	1,2,4,5,9, 10,11,12	60	40	100
46.	20EC251	Digital Logic Circuits	2	0	2	3	1,2,3,5,9, 10,12	50	50	100
47.	20EC252	Microcontrollers and Programming	2	0	2	3	1,3,4,5,9, 10,11,12	50	50	100
48.	20EI201	Elements of Instrumentation	2	0	0	2	1	40	50	100
49.	20EI202	Sensors and Its Application	2	0	0	2	1	40	50	100
50.	20EI203	Aerospace sensors and Instrumentation	2	0	0	2	1	40	60	100
51.	20EI204	Electric circuits and Electronic Devices	3	0	0	3	1,2	40	60	100
52.	20EI251	Sensors and Instrumentation	2	0	2	3	1,2,4,5,9,10	50	50	100
53.	20EI271	Simulation Laboratory	0	0	2	1	1,2,4,5,9,12	60	40	100
54.	20EI272	Aerospace Sensor and Instrumentation Laboratory	0	0	2	1	1,2,4,5,9,10 ,12	60	40	100
55.	20EI218	Control Systems in Aeronautics	2	0	0	2	1,2,3,5	40	60	100

56.	20IT201	Problem Solving and Computer Programming	3	0	0	3	1,2,9	40	60	100
57.	20IT202	Object Oriented Programming Concepts	3	0	0	3	1,2,9	40	60	100
58.	20IT241	Programming in Python	2	0	0	2	1,2,9	40	60	100
59.	20IT242	Object Oriented Programming	3	0	0	3	1,2,9	40	60	100
60.	20IT243	Data Structures and Algorithms	3	0	0	3	1,2,9	40	60	100
61.	20IT244	Python Programming	3	0	0	3	1,2,9	40	60	100
62.	20IT251	Multimedia Principles and Web Design	1	0	2	2	1,2,3,5,9,10	50	50	100
63.	20IT261	R Programming for Data Science	2	0	2	3	1,2,5	50	50	100
64.	20IT270	C Programming Laboratory	0	0	2	1	1,2,3	60	40	100
65.	20IT271	Object Oriented Programming Laboratory	0	0	2	1	1,2,3	60	40	100
66.	20IT291	Programming in Python Laboratory	0	0	2	1	1,2,3	60	40	100
67.	20IT292	Object Oriented Programming using C++ Laboratory	0	0	2	1	1,2,3	60	40	100
68.	20IT293	Data Structures and Algorithms Laboratory	0	0	2	1	1,2,3	60	40	100
69.	20IT294	Python Programming Laboratory	0	0	2	1	1,2,3	60	40	100
70.	20IT252	Java Programming	2	0	2	3	1,2,3,5,9, 10,12	50	50	100
71.	20IT272	Programming in C++ Laboratory	0	0	2	1	1,2,3,9,10, 12	60	40	100
72.	20IT295	Programming Skills Laboratory	0	0	2	1	1,2,3,9,10, 12	60	40	100
73.	20ME201	Engineering Thermodynamics	2	1	0	3	1,2	40	60	100
74.	20ME202	Manufacturing Technology	3	0	0	3	1,2,5	40	60	100
75.	20ME204	Computational Mechanics	3	1	0	4	1,2,5	40	60	100
76.	20ME205	Thermal Engineering and Fluid Mechanics	3	0	0	3	1,2	40	60	100
77.	20ME208	Robotics	2	0	0	2	1,2	40	60	100
78.	20ME271	Engineering Graphics	0	0	4	2	1,2,9,10,12	60	40	100
79.	20ME272	Computer Aided Engineering Graphics Laboratory	1	0	2	2	1,5,9,10	60	40	100
80.	20ME273	Engineering Practices Laboratory	0	0	2	1	1,2,5,9,10,12	60	40	100
81.	20ME211	Strength of materials	2	1	0	3	1,2,3	40	60	100
82.	20ME213	Resource management and optimization techniques	2	0	0	2	1,2,4,5,11	40	60	100
83.	20ME226	Introduction to Robotics	2	0	0	2	1,12	40	60	100
84.	20EE240	Fundamentals of Electrical and Electronics Engineering	3	0	0	3	1,2,5,9,10	40	60	100
85.	20EE281	Fundamentals of Electrical and Electronics Engineering Laboratory	0	0	2	1	1,2,4,5	60	40	100
86.	20EC204	Digital System Design	3	0	0	3	1,2,3	40	60	100

****OPEN ELECTIVES (OEs)**										
Electives Offered by B.E. Aeronautical Engineering										
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**POs**	**CA**	**ES**	**TOTAL**
1.	20AE2E51	Modelling of Mini and Micro Air Vehicles	3	0	0	3	2, 3, 7	40	60	100
2.	20AE2E52	Fundamentals of Applied Aeronautical Sciences	3	0	0	3	2, 3	40	60	100
3.	20AE2E53	Vehicle Aerodynamics	3	0	0	3	1, 2	40	60	100
4.	20AE2E54	Automotive Aerodynamics	3	0	0	3	1, 5	40	60	100
5.	20AE2E55	Space: The Final Frontier	3	0	0	3	1	40	60	100
6.	20AE2E56	Electric Aviation	3	0	0	3	1, 7	40	60	100
Elective Offered by B.Tech. Artificial Intelligence and Data Science										
7.	20AD2E51	Python Frameworks for Machine Learning	2	0	2	3	1,2,3,4,5,6, 12	50	50	100
Electives Offered by B.E. Biomedical Engineering										
8.	20BM2E31	Healthcare Technology	3	0	0	3	1,5	40	60	100
9.	20BM2E32	Materials in Medicine	3	0	0	3	1,5	40	60	100
Electives Offered by Department of Chemistry										
10.	20CH2E51	Nano Materials for Energy and Environment	3	0	0	3	1,7	40	60	100
11.	20CH2E52	Green Chemistry for Engineers	3	0	0	3	1,7	40	60	100
12.	20CH2E53	Analytical Chemistry	3	0	0	3	1	40	60	100
13.	20CH2E54	Environmental Science and Sustainability	3	0	0	3	1,7	40	60	100
Electives Offered by B.E. Civil Engineering										
14.	20CE2E51	Waste Management	3	0	0	3	1,2,6,7,11	40	60	100
15.	20CE2E52	Global warming and climate change	3	0	0	3	1,3,5,7,11	40	60	100
16.	20CE2E53	Geographical Information System	3	0	0	3	1,2,5	40	60	100
17.	20CE2E54	Disaster management	3	0	0	3	1,2,5,11	40	60	100
18.	20CE2E55	Environmental Management in Industry	3	0	0	3	1,2,7	40	60	100
19.	20CE2E56	Remote Sensing and GIS For Urban Planning and Management	3	0	0	3	1,2,3,5,6,7,8	40	60	100
20.	20CE2E57	Habitat Sustainability	3	0	0	3	1,2,3,6,7	40	60	100
21.	20CE2E58	Occupational Health and Safety	3	0	0	3	1,2,5,6,7,8,1 2	40	60	100
Electives Offered by B.E. Computer Science Engineering										
22.	20CS2E61	Python for Data Science	3	0	0	3	1,2,3,4,5,12	40	60	100
23.	20CS2E62	Data Analytics	3	0	0	3	1,2,3,4,5,11 ,12	40	60	100
24.	20CS2E63	Java Programming	3	0	0	3	1,2,3,4	40	60	100
25.	20CS2E64	Machine Learning	3	0	0	3	2,3,4,11,12	40	60	100
26.	20CS2E65	Cyber Security	3	0	0	3	2,3,4.11,12	40	60	100

Electives Offered by B.E.Electrical and Electronics Engineering										
27.	20EE2E51	Renewable Energy Systems	3	0	0	3	1,6,11	40	60	100
28.	20EE2E52	Power Generation Systems	3	0	0	3	1,6,7,11	40	60	100
29.	20EE2E53	Troubleshooting of Electrical Apparatus	3	0	0	3	1,3,4,12	40	60	100
30.	20EE2E54	Electric and Hybrid Vehicles	3	0	0	3	1,2,9,10	40	60	100
31.	20EE2E55	Electrical Machines and Drives	3	0	0	3	1,2	40	60	100
Electives Offered by B.E. Electronics and Communication Engineering										
32.	20EC2E51	Consumer Electronics	3	0	0	3	1,2,3,6	50	60	100
33.	20EC2E52	MEMS and NEMS	3	0	0	3	1	50	60	100
34.	20EC2E53	Image Processing and Applications	3	0	0	3	1,2,5,11,12	50	60	100
35.	20EC2E54	Internet of Things	3	0	0	3	1,3,12	40	60	100
Electives Offered by B.E. Electronics and Instrumentation Engineering										
36.	20EI2E12	Programmable Logic Controller	3	0	0	3	1,2,5	40	60	100
37.	20EI2E13	Automation and Machine Vision Systems	3	0	0	3	1,2	40	60	100
38.	20EI2E14	Testing and Calibration of Equipment's	3	0	0	3	1,2,5	40	60	100
39.	20EI2E17	Industrial Pollution and Control	3	0	0	3	1,7	40	60	100
Electives Offered by B.Tech. Information Technology										
40.	20IT2E51	Android Application Development	3	0	0	3	1,2, 3,5, 12	40	60	100
41.	20IT2E52	Database Systems	3	0	0	3	1,2,3,4,5, 12	40	60	100
42.	20IT2E53	Foundations of IT	3	0	0	3	1,2,3,12	40	60	100
43.	20IT2E54	Introduction to Data Science	3	0	0	3	1,2,3,4,5,12	40	60	100
Electives Offered by B.E. Mechanical Engineering										
44.	20ME2E01	Intellectual Property Rights for Engineers	3	0	0	3	5,6,7,8,10, 12	40	60	100
45.	20ME2E52	Engineering Economics	3	0	0	3	1,2,11	40	60	100
46.	20ME2E53	Entrepreneurship and Finance Management	3	0	0	3	1,2,5,11	40	60	100
47.	20ME2E54	Project Management	3	0	0	3	1,5,11	40	60	100
Electives Offered by Department of Physics										
48.	20PH2E01	Characterization of Nanostructures	3	0	0	3	1,5	40	60	100
49.	20PH2E02	Non-Conventional Energy Resources	3	0	0	3	1,5	40	60	100
50.	20PH2E03	Solar Technology	3	0	0	3	1,5,6	40	60	100

Electives Offered by B.E. Robotics and Automation										
51.	20RA2E51	Automation in Industry 4.0	3	0	0	3	1,6	40	60	100
52.	20RA2E52	Social Robotics	3	0	0	3	1,6,7,8	40	60	100
53.	20RA2E53	Embedded Systems for Robotic Applications	3	0	0	3	1,2	40	60	100
54.	20RA2E54	Robotic System Engineering	3	0	0	3	1,2,3,9,12	40	60	100
Electives Offered by M.Tech. Nanoscience andTechnology										
55.	20NT2E01	Fundamentals and Applications of Nanoscience and Nanotechnology	3	0	0	3	1,3,7	40	60	100
56.	20NT2E02	Nanotechnology In Environmental Remediation	3	0	0	3	1,3,7	40	60	100
Electives Offered by Department of Mathematics										
57.	20MA2E01	Mathematics for Data Science	3	0	0	3	1,2,5,9	40	60	100
58.	20MA2E02	Mathematics for Machine Learning	3	0	0	3	1,2,5,9	40	60	100
59.	20MA2E03	Operations Research	3	0	0	3	1,2,5,9	40	60	100
60.	20MA2E04	Statistics for Big Data Analytics	3	0	0	3	1,2,5,9	40	60	100
61.	20MA2E05	Graph Theory and Its Applications	3	0	0	3	1,2,5,9	40	60	100
Electives Offered by Department of English										
62.	20EN2E01	Life Skills & Personality Development	2	1	0	3	9,10,12	100	-	100
63.	20EN2E02	Art of Speaking	1	2	0	3	9,10,12	100	-	100
64.	20EN2E03	Generic Skills For Employability	2	1	0	3	9,10,12	100	-	100
65.	20EN2E04	Gender Perspective in Team Building and Leadership	3	0	0	3	9,10,12	40	60	100

*** Candidates should choose the open elective not from the Programme of the Student*

9 Credits to be completed from list

ONE CREDIT COURSES(OCs)			
B.E. Aeronautical Engineering			
S.No.	**Course Code**	**Course Title**	**Offering Industry**
1.	20AEI002	Lean Manufacturing	Premier Fine Linens, Coimbatore
2.	20AEI003	Cessna 152 Aircraft and R11F2S300 Engine	Air Works, Hosur
B.E. Biomedical Engineering			
3.	20BMI001	Medical Equipment Training	Prashan Medical Technologies, Coimbatore
4.	20BMI002	Machine Learning in Healthcare Application	VisionCog Research & Development Pvt. Ltd. Thiruvananthapuram
5.	20BMI003	3D Printing for Medical and Robotics Use	Medsby Healthcare and Engineering Solutions, Coimbatore
6.	20BMI004	Foundation in Clinical Research	Skyline CRS, CatchU Academy ,Coimbatore
7.	20BMI005	IR Thermography in Engineering	BAMARA Techware (Teledyne FLIR), Coimbatore
B.E. Civil Engineering			
8.	20CEI001	Construction Safety	Vijaya Builders, Coimbatore
9.	20CEI002	Water Audit	Department of Civil Engineering, Sri Ramakrishna Engineering College
10.	20CEI003	Geotechnical Exploration And Investigation	Minerva Civil Lab Testing Pvt. Ltd., Chennai
11.	20CEI004	Design of High Performance Concrete	Roads & Bridges L&T IDPL, Chennai
12.	20CEI005	Non - Destructive Testing Practices	Roads & Bridges L&T IDPL, Chennai
13.	20CEI006	Analysis and Design of Structures	Mithran Structures, Coimbatore.
14.	20CEI007	Fire Safety	VikrutiStructures,Coimbatore.
15.	20CEI008	Planning and Design of Industrial Structures	SV Consultants, Coimbatore.
16.	20CEI009	Day Lighting And Ventilation	Inhabitat Landscape, Coimbatore
17.	20CEI010	Building Automation Techniques	Sri Ramakrishna Engineering College, Coimbatore.
B.E. Computer Science Engineering			
18.	20CSI001	NextGen Imaging	Wipro Technologies, Bengaluru
19.	20CSI002	Introduction to Design of Wearable Medical Devices	HTIC,IIT Madras, Chennai
20.	20CSI003	Emerging Technologies & Innovation	Wipro Limited, Bengaluru
21.	20CSI004	Full Stack Development	Triosrex Private Limited, Coimbatore
22.	20CSI005	Hands on Medical Image Processing with Simpleitk	HTIC, IITM, Chennai
23.	20CSI006	Applied Matrix Operations	HTIC, IITM, Chennai
24.	20CSI007	Deep Learning & Image processing using Convolutional Neural Networks (CNN)	BuzzTech Training Institute, Coimbatore

25.	20CSI008	Industrial Coding Standards,	OrbidX, Coimbatore
26.	20CSI009	Programming Techniques for Super Computers	IBM, Bengaluru
27.	20CSI012	Agile – Dev Ops Methodology	IBM, Bengaluru
B.E. Electrical and Electronics Engineering			
28.	20EEI001	Industrial IoT (using fully open source)	Kalycito Info Tech Pvt. Ltd., Coimbatore
29.	20EEI002	Energy Management and Audit	Encon Energy Solutions, Coimbatore
30.	20EEI003	Solar PV Installation and Commissioning	Progen Energy Solutions, Coimbatore
31.	20EEI004	Power Semiconductors - Characteristics, Driving and Applications	ABB Limited, Chennai
32.	20EEI005	Industrial Automation (PLC and SCADA)	Axis Global Automation, Coimbatore
33.	20EEI006	Magnetics	Salzer Electronics Pvt. Ltd, Coimbatore
34.	20EEI007	E-Vehicle: The Future	Spero Bikes, Coimbatore
35.	20EEI008	Cyber Security Enabled IoT	Central Power Research Institute, Bangaluru
B.E. Electronics and Communication Engineering			
36.	20ECI001	Introduction to Augmented Reality	Praya Labs, Tiruvannamalai
37.	20ECI002	Reverse Engineering With Sensors	Profenaa Technologies, Coimbatore
38.	20ECI003	Machine Learning - Application Perspective	KrishTech, Coimbatore
39.	20ECI004	LoRa Gateway Design & Application	KrishTech, Coimbatore
40.	20ECI005	Embedded Communication Protocols	S&S Power Systems, Chennai
41.	20ECI006	PCB Design and Fabrication	Enthu Technology Solutions India Pvt. Ltd, Coimbatore
42.	20ECI007	Embedded and IoT	Capegemini Engineering, Coimbatore
43.	20ECI008	Connected Car-Electronics	KrishTech, Coimbatore
44.	20ECI009	Digital Twin	Praya Labs, Tiruvannamalai
45.	20ECI010	Antenna Engineering	Entuple Technologies, Bengaluru
B.E. Electronics and Instrumentation Engineering			
46.	20EII001	Automation And Control	FLSmidth Pvt., Ltd., Chennai
47.	20EII002	Machine Learning For Instrumentation-Application Perspective	Krishtech, Bangalore
48.	20EII003	Quality Control And Investment Portfolio Management	Triosrex Pvt., Ltd., Bangalore
49.	20EII004	Sensors and Its Application In Industrial Automation	MELZ Indcosys Solutions, Coimbatore
50.	20EII005	Industrial Pneumatics	Janatics India Pvt., Ltd., Coimbatore

B.Tech. Information Technology			
51.	20IT2I02	Mobile Web Application Development with ColdFusion	Ladder Minds, Coimbatore
52.	20IT2I03	IBM Cloud Private With Linux On Z Systems	IBM, Bengaluru
53.	20IT2I04	Blockchain on IBM Mainframe	
54.	20IT2I05	iOS App Development Basics	Mallow Technologies Pvt Ltd, Karur
55.	20IT2I06	Ethical Hacking and Cyber Security	Hackup Technology, Coimbatore
56.	20IT2I07	Artificial Intelligence	Hewlette Packard Enterprise, Bengaluru
57.	20IT2I08	Blockchain and Enterprise Applications	RapidQube, Mumbai
B.E. Mechanical Engineering			
58.	20MEI001	Programmable Logic Control (PLC)	M/s. TVS Training and Services Ltd, Chennai.
59.	20MEI002	Introduction to Injection Moulding Process	M/s. Salzer Electronics Ltd, Coimbatore.
60.	20MEI003	Geometric Dimensioning & Tolerancing	Roots Industries India limited, Coimbatore
61.	20MEI004	Advanced Cast Irons and Foundry Management	M/s. Indoshell Cast Private Limited, Coimbatore
62.	20MEI005	Heat Treatment of Steel Castings	M/s. Flow Link Systems, Coimbatore.
63.	20MEI006	Industrial Automation	M/s. Maple Tech Solutions, Hosur
64.	20MEI007	Industrial Safety	
65.	20MEI008	Metal Additive Manufacturing	M/s. Wipro Enterprises, Bengaluru
66.	20MEI009	Non Destructive Testing	M/s Shri Sai NDT, Pondicherry
67.	20MEI010	HVAC building load calculations and psychrometry	M/s Sigma Solutions, Coimbatore
68.	20MEI011	HVAC Air distribution system	
69.	20MEI012	Control automation	M/s Axis Global automation, Coimbatore
70.	20MEI013	Tool design	M/s Mechtech Engineering centre, Coimbatore
		M.Tech. Nanoscience and Technology	
71.	20NTI001	Physical Characterization and Applications of Nanomaterials	M.Tech Nanoscience and Technology, Sri Ramakrishna Engineering College, Coimbatore
72.	20NTI002	Optical Characterization and Applications of Nanomaterials	
73.	20NTI003	Electrochemical Characterization and Applications of Nanomaterials	

Department of Robotics and Automation			
54.	20RAI001	Exploring ROS Basics and Modelling	RigBetel Labs, Pune
55.	20RAI002	ROS Tools, Mapping and Navigation	RigBetel Labs, Pune
56.	20RAI003	Industrial Electric Panel Design	ADNA Automation,Coimbatore
57.	20RAI004	Motion Control	Dr.Kuppan Chetty, Hindustan University.
58.	20RAI005	Automation using PLC, SCADA and HMI	Axis Global Institute of Industrial Training, Coimbatore
59.	20RAI006	Robotic Simulation using Moto Sim Software	Axis Global Institute of Industrial Training, Coimbatore

Employability Enhancement Courses (eec)										
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**POs**	**CA**	**ES**	**TOTAL**
1.	20XXX	Mini Project - I	0	0	4	2	1-12	60	40	100
2.	20XXX	Mini Project - II	0	0	4	2	1-12	60	40	100
3.	20XXX	Project Work	0	0	16	8	1-12	60	40	100
4.	20XXX	Internship / Startup / Entrepreneurship	0	0	4	2	1-12	60	40	100
5.	20XXX	Industrial One Credit Course	0	0	4	1	1-12	60	40	100

HUMANITIES AND SOCIAL SCIENCES (HS)

ENLIGHTENMENT THROUGH EDUCATION
SREC

20AE201 **INDIAN SPACE MISSIONS** **1 0 0 1**

COURSE OUTCOMES

On Successful completion of the course, students will be able to

CO1:	Explain the policies and milestones accomplished by Indian space Programme	PO6
CO2:	Summarize the Indian space missions with numerous launch vehicles	PO5, PO6
CO3:	Describe the navigation and communication systems employed in space science	PO5, PO6
CO4:	Recognize the roles of the Indian space centers and its parent organizations	PO6

GENESIS OF INDIAN SPACE PROGRAMME **2**

Major Milestones in Indian Space Programme, Indian Space Policy

INDIAN SPACE MISSIONS **3**

Mars Orbiter Mission, LVM3-X (CARE), Astrosat, GSAT-30, PSLV-C48, PSLV-C47, Chandrayaan, Chnadrayaan 2, Future Missions.

INDIAN SPACECRAFT **2**

Communication, Earth Observations, Navigations, Space Science, Experimental and Small Satellites, Student Satellites

LAUNCHERS **3**

Historic:SLV. ASLVOperational: PSLV, GSLV, GSLV Mk III,Sounding Rockets,

Future:RLV-TD, Scramjet Engine-TD.

APPLICATIONS **2**

Earth Observation, Disasaster Management Support and Satellite Communication.

INDIAN SPACE CENTERS **2**

Department of Space and ISRO.

INDIAN DEFENCE ORGANISATION **1**

Department of Defence, DRDO and centers.

Total Hours: 15

REFERENCES

1. From Fishing Hamlet to Red Planet, "Indian's Space Journey", P.V.Manorajan Rao, 2015.
2. Publications from Space Science missions.

WEB REFERENCES

1. https://www.space.com/indian-space-research-organization.html
2. https://www.dos.gov.in/

20AE203 AVIATION MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Illustrate the air transport commercial practices and uses.	PO1
CO2:	Explain the management perspectives.	PO1
CO3:	Explain about the economical strategy of airline industry.	PO1
CO4:	Describe the scheduling procedures based on various factors.	PO1

AVIATION INDUSTRY & AIRLINE MANAGEMENT **15**

Development of air transportation - Comparison with other modes of transport - IATA, ICAO, EASA, FAA, DGCA, UAM, MIL, QMS 9100 - The general aviation industry airline - Factors affecting general aviation - uses of aircraft - Airline management: Levels of management, functions of management, Organization: Principles, Chart, Staff departments and line departments.

AIRLINE ECONOMICS **12**

Forecasting: purposes, methods - Airline pricing: pricing and demand, types of passenger fares, pricing process, airline costs, pricing and output determination - Aircraft selection process: Technical aspects, Fleet rationalization, Fleet commonality, Factors affecting choice of fleet, Fleet planning process.

PRINCIPLES OF AIRLINES SCHEDULING **18**

Equipment maintenance - Flight operations and crew scheduling - Ground operations and facility limitations - Equipments and types of schedule - Hub & spoke scheduling - Aircraft reliability - Maintenance schedule and its determination - Aircraft scheduling with reference to engineering.

Total Hours: 45

TEXT BOOKS

1. L Alexander T Wells, "Air Transportation", 7th Edition, Wadsworth Publishing Company, 2011.
2. Fedric J.H. "Airport Management", Digitized Edition, Richard D. Irwing, 2007.

REFERENCES

1. Gene Kropf "Airline Procedures", Himalayan Book house, 1949.
2. Wilson & Bryon "Air Transportation". Himalayan Book house , 2006.
3. Philip Locklin D "Economics of Transportation", Richard D. Irwing, 1972.
4. Graham.A-Managing Airport an International Perspective -Butterworth Heinemann, Oxford-2001
5. Wells.A-Airport Planning and Management, 4th Edition-McGraw-hill, London-2000.
6. Doganis.R.-The Airport Business-Routledge, London-1992
7. Alexander T.Well, Seth Young -Principles of Airport Management-McGraw Hill 2003
8. P.S.Senguttuvan-Fundamentals of Airport Transport Management - McGraw Hill 2003

20BM207 HOSPITAL SYSTEM MANAGEMENT 2 0 0 2

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

CO1:	Express the process for technology procurement, handling and maintenance of medical devices in a hospital facility.	PO6
CO2:	Describe the concepts of financial assessment, risk management and employee management in medical industry.	PO8, PO9, PO11
CO3:	Explain the advantage and utility of information technology in medical data handling and communication.	PO6
CO4:	Summarize the requirements for the design and construction of hospital plant facility	PO6, PO7

HEALTH TECHNOLOGY MANAGEMENT **9**

Introduction to medical technology management practices, good management practice for medical equipments, health care strategic planning utilizing technology assessment, evaluation, procurement, equipment control and asset management, computerized maintenance management system, Maintenance of equipment- In-house and contract, various types of contracts, PM & CM- TQM applications-Types of Biomedical equipment- Impact analysis

MANAGEMENT ENGINEERING IN HEALTHCARE **7**

Industrial engineering in healthcare, financial management of clinical engineering services, cost-effectiveness and productivity, personnel management, skills identification, management styles and human resource development, quality -Patient safety and the clinical engineering- root cause analysis, HFMEA, risk management, patient safety.

HEALTH INFORMATION MANAGEMENT **7**

Physiologic monitoring and clinical information systems, Management Decision and related information requirement, electronic Medical record. Advanced diagnostics and artificial intelligence. Telemedicine: Clinical and operational issues. Picture Archiving and Communication Systems, DICOM.

ENGINEERING THE CLINICAL ENVIRONMENT **7**

Physical Plant, heating, ventilation, and air conditioning, electrical power, medical gas systems, support services, construction and renovation, radiation safety, sanitation, water systems in health care facilities, disaster planning - Accreditations -Health Care Quality and ISO. Hospital Facilities Safety Standards.

Total Periods: 30

TEXT BOOKS:

1. Roberto Miniati, Ernesto Iadanza, Fabrizio Dori, "Clinical Engineering from Devices to Systems", 1st Edition, Academic Press, 2016.
2. Ernesto Iandanza, "Clinical Engineering Handbook",2nd edition, Academic Press,Elsevier,2020.

REFERENCES:

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI-7th Edition,2017.
2. G.D.Kunders, "Hospitals -Facilities Planning and Management", TMH, New Delhi -5th edition Reprint 2007.
3. Arnold D. Kalcizony & Stephen M.Shortell, "Health Care Management", 6th Edition, 2011.
4. Azzam Taktak Paul Ganney David Long Paul White, Clinical Engineering, "A Handbook for Clinical and Biomedical Engineers", 1st Edition, Academic Press, 2013.
5. Joseph Dyro, "The Clinical Engineering Hand Book", Elsevier, 2004.

20BM208 REGULATORY AFFAIRS, BIO ETHICS AND INTELLECTUAL PROPERTY RIGHTS 2002

COURSE OUTCOMES:

On successful completion of this course, students will be able to

CO1:	Understand and explain the regulatory processes and the role of the regulatory process in the medical product lifecycle.	PO6
CO2:	Describe the bioethical principles and applications in biomedical research.	PO8
CO3:	Comprehend and articulate the various processes necessary to translate developments from research to products or services employable by the health sector	PO7
CO4:	Distinguish various aspects of intellectual capital, identify mechanisms available for establishing their rights and utilization	PO6

REGULATORY AFFAIRS **12**

Role of regulatory agencies and professionals; Medical devices-definition and life cycle; Risk based classification of medical devices; safety and effectiveness; Overview of the regulatory controls applicable during various stages of medical device life cycle; Familiarization with regulatory agencies - FDA, EU and CDSCO; Introduction to quality management systems and ISO standards in medical industry, ASTM Standards, Phases of Clinical trials.

PROFESSIONALISM AND ETHICS **8**

Morality, professional conduct and responsibility, legality. Health - private and public perspectives. Principles and applications of ethics in taking medical devices from laboratory to users.

INTELLECTUAL RIGHTS **4**

Framework, Agreements and Laws. GATT and TRIPS, WTO. International conventions, limitations and leverages.

INTELLECTUAL PROPERTY **6**

Types, organizations, processes, implementations.

Total : 30

TEXTBOOKS

1. Val Theiz, "Medical Device regulatory practices: An international Perspective", Pan Stanford, 2015
2. Sree Krishna V, "Bioethics and Biosafety in Biotechnology", New Age International, 2007.
3. Alikhan S and R Mashelkar , "Intellectual Property and competitive strategies in the 21st century", Wolters Kluwer, 2009.

REFERENCES

1. Stephen F. Amato (ed.), Robert M. Ezzell Jr. (ed.), "Regulatory Affairs for Biomaterials and Medical Devices", Woodhead Publishing, 2014
2. WIPO Academy -Courses and Study Materials

WEB REFERNCES

1. http://eumdr.com/
2. https://www.fda.gov/
3. https://cdsco.gov.in/opencms/opencms/en/Home

20CE206 **ARCHITECTURAL CONSERVATION AND HISTORIC PRESERVATION** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Recall the importance of historic conservation and preservation to strengthen cultural integrity.	PO6
CO2:	Interpret the necessary techniques for maintaining and preserving architectural and historic sites.	PO1, PO7
CO3:	Evaluate the various categories of historic conservation and select appropriate preservation techniques.	PO1
CO4:	Investigate the heritage structures and prepare a conservation report	PO1, PO2

HERITAGE CONSERVATION **7**

Introduction - heritage conservation- need, debate and purpose - understanding heritage - types of heritage resources. Zones and historic areas; planning for heritage districts, towns and cities - values and significance - value assessment, approaches of conservation. Divergent approaches - ethics of conservation - history of conservation movement; concepts and definitions - International agencies like ICCROM, UNESCO and their role in conservation.

HISTORIC PRESERVATION **8**

World Heritage Sites, selection criteria, authenticity and integrity, case studies, endangered sites.

Categories, Types and issues of heritage precincts - Causes of decay - listing, documentation - assessment of heritage structures, sites and precincts. Investigation - state of preservation and preparing conservation report, guidelines for maintenance and repair - case studies

Total Hours: 15

REFERENCES

1. Cullinane, J. J. Maintaining and Repairing Old and Historic Buildings. Wiley-Blackwell, 2018.
2. Croci, G. The Conservation and Structural Restoration of Architectural Heritage. Southampton, UK: WIT Press, 2017
3. Fitch, J.M.. Historic Preservation: Curatorial Management of the Built World. Virginia: 5th printing 2016.

WEB REFERENCES

1. https://www.futurelearn.com/courses/heritage-matters
2. https://www.mooc-list.com/course/cities-yesterday-today-and-tomorrow-why-heritage-conservation-matters

20CE207 CULTURAL IMPLICATIONS ON BUILDING DESIGN 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Interpret the influence of cultural changes in historical and industrialized structures.	PO6
CO2:	Develop a model of structures based on cultural development.	PO1, PO3, PO6, PO9

HISTORICAL EVOLUTION **5**

Study of vernacular architecture - traditional way of life of people -Understanding the impact of social and physical environment - climate of the place- Impact on materials and methods of building construction. Cross-cultural understanding of factors influencing early settlement and built form, Indus Valley Civilization and the early Aryan architecture of the Ganga basin, Vedic principles of planning.

INFLUENCE OF FOREIGN ARCHITECTURE **7**

Architecture of Egypt, West Asia (Mesopotamia, Assyria, neo-Babylon and Persia), China, Pre-Columbian America, Greece (Aegean to Hellenistic times) and Rome - Inception and development of Buddhist architecture in India - overview of developments in South East Asia, Japan, China and the Silk Route - Growth and development of the bungalow, the hill station, the cantonment and the residency in response to the perceived needs of the British in India; Indo-Saracenic Architecture of the Indian sub-continent;

IMPACTS OF INDUSTRIALISATION &CULTURE **3**

The Industrial revolution and its impact - Initiation of modern architecture and town planning- Issues related to the growing problems of urban areas in the world and their future development. Design with relation to the contextual environment, heritage and impact analysis.

Total Hours: 15

REFERENCES

1. Koc Gulah and ClaesMarie-Therese, "Cultural Influences on Architecture" IGI Global, 2017
2. Amos Rapoport , "Culture, Architecture and Design" Locke Science Publishing Co., Inc., 2005

20CE224 CIRCULAR ECONOMY FOR SUSTAINABLE BUILT ENVIRONMENT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify areas where circular economy principles can be applied to the Built Environment through multi-scalar design strategies	PO2, PO5, PO7

INTRODUCTION **15**

Built environment - Housing demand -recent building technologies and design strategies -building products and materials - life-cycle performance of buildings-linear economy versus circular economy - principles of Circular Economy - design for disassembly -case studies in the design and development process of buildings - circularity in buildings connecting water, energy and waste - geographical significance of building products-environmental impacts

Total hours: 15

TEXT BOOKS

1. David Cheshire, Building Revolutions: Applying the Circular Economy to the Built Environment, CRC Press, Taylor & Francis Group, Florida, 2020.
2. Ramjeawon, T. Introduction to Sustainability for Engineers, CRC Press, Taylor & Francis Group, Florida 2020.

WEB REFERENCES

1. https://www.edx.org/course/circular-economy-for-a-sustainable-built-environ-2
2. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1

20CE225 PRINCIPLES OF CONSTRUCTION MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1:	Define construction management principles, classification, stages and organization types	PO1
CO2:	Describe the construction planning and resource planning in project management	PO1
CO3:	Compute construction schedules, network diagrams and time estimates of projects	PO1,PO5
CO4:	Infer the cost required for each activity in construction to prepare tender document, Contract types and report.	PO2,PO10, PO11
CO5:	Summarize the Quality control measures and safety in construction	PO1
CO6:	Describe the basic concepts of lean techniques and productivity in construction management.	

PRINCIPLES OF CONSTRUCTION MANAGEMENT **6**

Definition - Principles of Construction Management - Classification and stages of Construction - Contracting firms - Organization - Types of organizations.

CONSTRUCTION AND RESOURCE PLANNING **6**

Construction Planning: Collection of field data - Preliminary estimates - Approval and sanction of estimates - Budget provision - Construction stages - Scheduling methods - Progress report and charts - Resource Planning

TECHNIQUES FOR CONSTRUCTION MANAGEMENT **9**

Bar Chart- Mile stone chart- Work break down structure and Preparation of networks - Network techniques like PERT and CPM in construction management- Calculations for scheduling with leads, lags and windows - Resource oriented scheduling - Scheduling with resource constraints and precedence - Use of Advanced Scheduling Techniques -Scheduling with uncertain durations Project monitoring and resource allocations through network techniques.

CONTRACT MANAGEMENT **9**

Contractors: Contract system - Types of contracts - Specifications, documents, procedures, conditions, taxes, law of constructions and Legal implications and penalties. Tender And Tender Documents: Definition - Calling for tenders - Tender documents submission of tenders - Processing of tenders - Negotiations and settlement of contracts - Labour Regulations.

QUALITY CONTROL AND SAFETY DURING CONSTRUCTION **9**

Quality and safety Concerns in Construction - Organizing for Quality and Safety - Work and Material Specifications - Total Quality control - Quality control by statistical methods - Statistical Quality control with Sampling by Attributes - Statistical Quality control by Sampling and Variables-Safety.

LEAN CONSTRUCTION TECHNIQUES **6**

Overview of Lean Technology - Techniques for Lean Management: Five Whys, Pareto analysis, Fishbone diagram;

Waste response -Tools in Lean Construction: Productivity Improvement - Process, machinery Operator and equipment; Enabling lean through information technology.

Total hours: 45

TEXT BOOKS

1. Chitkara, K.K. "Construction Project Management Planning", Scheduling and Control, Tata McGraw Hill Publishing Co., New Delhi, 2009.
2. B.C. Punmia, K.K. Khandelwal., "Project Planning and Control with PERT and CPM" 4th Edition Laxmi Publications, 2016.

REFERENCES

1. Dr. M.S. Roy., "Quantity Surveying and Contract & Tenders" 1st Edition, Vayu Education of India 2015.
2. P S Gahlot, "Construction Planning And Management" New Age, International, 2007
3. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.

WEB REFERENCES

1. http://nptel.ac.in/courses/105104101/ nptel-aic/construction planning and management -intro.pdf
2. https://nptel.ac.in/courses/105/103/105103093/

ENLIGHTENMENT THROUGH EDUCATION SREC

20CE226 LEAN CONSTRUCTION TECHNOLOGY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the principles of construction management, organization and activity, Techniques in lean construction	PO1
CO2:	Outline the quality control and safety in construction management.	PO1
CO3:	Explain core concepts of lean construction and its importance in productivity.	PO1
CO4:	Apply the concepts of lean construction tools and techniques in construction industry	PO2, PO5, PO7, PO11
CO5:	Predict the lean implementation to achieve sustainability in construction design and modeling.	PO2, PO5, PO7, PO11

INTRODUCTION TO CONSTRUCTION PROJECT MANAGEMENT **12**

Project -Definition, Classification, Project Life cycle; Project Management - Definition, Objectives, Functional areas; Management of Resources-Material, Labour, Money, Time, Equipment; Planning and Scheduling of Resources -Work breakdown structure,Concepts of Critical Path Method, Program Evaluation and Review Technique.Traditional Construction management techniques and their problems; Comparison between Traditional and Lean construction project.

LEAN CONSTRUCTION **6**

Lean Management -Lean Production; Evolution of Lean Construction; Production theories in construction - Productivity, Daily Progress Report,Value in Construction sector, Forms of waste in construction industry.

CONCEPTS IN LEAN CONSTRUCTION **9**

Principles of lean construction -Value identification, Value Stream, Workflow reliability and work structuring, Pull planning, Continuous improvement; Variability and its impact; Lean Project Delivery system; Production Control.

LEAN CONSTRUCTION TOOLS AND TECHNIQUES **9**

Waste management Framework: Waste Detection -Value stream mapping, Construction process analysis, Spaghetti diagram; Waste Processing -5 Whys, Pareto analysis, Fishbone diagram; Waste response -5S, Just-In-Time, Visual Management, Last Planner system, Huddle meetings, Kanban cards, Look ahead Schedule, Six Sigma.

LEAN CONSTRUCTION IMPLEMENTATION **9**

Lean construction implementation - Training, selecting the members, preparing project plan, implementation, review. Productivity Improvement: Process, machinery Operator and equipment; Enabling lean through information technology; Lean through Building Information Modelling; Sustainability through lean construction approach

Total Hours: 45

TEXT BOOKS

1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.

REFERENCES

1. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., and Tzortzopoulos, P., Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
2. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
3. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

WEB REFERENCES

1. https://www.buildingsguide.com/blog/introduction-lean-construction/
2. https://www.leanconstruction.org/wp_content/uploads/2019/06/LeanConstructionDefined.pdf
3. http://ieomsociety.org/ieomdetroit/pdfs/256.pdf

ENLIGHTENMENT THROUGH EDUCATION SREC

20CS203 SOCIOLOGY OF DIGITAL MEDIA 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Apply relevant digital media skills in a variety of perspectives including liberal arts, history, communication and information theory.	PO1, PO2, PO3, PO6, PO7, PO8, PO9, PO10
CO2:	Analyze the theories of media studies for the better transformation of conceptual ideas to innovative and productive digital media	PO2, PO3, PO6, PO7, PO8, PO9, PO10, PO12

PROFESSIONAL DIGITAL PRACTICE

Digital media tools for professional purposes: to build networks, construct an e-profile, publicise and share research and instruct students.

SOCIOLOGICAL ANALYSES OF DIGITAL USE

Researching the ways in which people's use of digital media configures their sense of selves, their embodiment and their social relations.

DIGITAL DATA ANALYSIS

Using digital data for social research, either quantitative or qualitative.

CRITICAL DIGITAL SOCIOLOGY

Undertaking reflexive and critical analysis of digital media informed by social and cultural theory.

Total Hours: 15

TEXT BOOKS

1. Alessandro Delfanti & Adam Arvidsson, "Introduction to Digital Media", Wiley Blackwell,1st Edition , 2019.
2. Simon Lindgren , "Digital Media and Society", 1st Edition, SAGE Publications Ltd,2018.

REFERENCES

1. Deborah Lupton, "Digital Sociology", Routledge, 2015.
2. Nigel Chapman, Jenny Chapman, "Digital Media Tools", 3rd Edition, Wiley, 2014.

WEB REFERENCES

1. https://www.researchgate.net/publication/248381396_Introducing_digital_sociology
2. https://www.researchgate.net/publication/308093817_Digital_sociology

20CS231 ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the basics of entrepreneurship, business models and startup management.	PO2, PO3, PO12
CO2:	Outline the roles of entrepreneurship development institutions in creating the startup culture.	PO6, PO7, PO11
CO3:	Apply the innovative entrepreneurship skills in the development of business models for setting up of startups.	PO5, PO6, PO7, PO9, PO10, PO11
CO4:	Examine the overall success of the venture after its transformation from ideas to implementation.	PO5, PO6, PO7, PO9, PO10, PO11

INTRODUCTION TO ENTREPRENEURSHIP **15**

Entrepreneurship - Concept and Definitions - Entrepreneurship and Economic Development - Classification of Entrepreneurs - Traits and Qualities of a successful Entrepreneur -Role of Entrepreneurial Institutions in Entrepreneurship Development-Various Schemes and Incentives-Venture Capitalists - Angel Investors- E cells - Entrepreneurship Development Programmes - Social Entrepreneurship

DEVLOPMENT OF BUSINESS MODEL **15**

Innovation and creativity in the current business scenario- Challenges of Innovation- Business models and value propositions- opportunity analysis and idea generation- Evaluation- Feasibility analysis- Business Plan - Developing a Business Plan - Project Management -Tools and Techniques of Project Management - Project Development Cycle-potential fatal flaws of business models

TRANSFORMATION OF BUSINESS MODEL INTO STARTUP **15**

Startup Culture in India-Gaining marketing Intelligence- Customer Segments, Channels and Partners, Revenue Model and Streams- Effective marketing- financial performance analysis and budgeting- Establishing an ethical culture in the firm- understanding the legal and regulatory aspects for the venture- Obtaining Business Licenses and permits- Strategic improvement plans

Total Periods : 45

TEXT BOOKS

1. Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2018.
2. Donald F Kuratko, "Entrepreneurship - Theory, Process and Practice", 9th Edition, Cengage Learning, 2014.

REFERENCES

1. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
2. Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis" 2nd Edition, Dream tech, 2005.
3. Rajeev Roy, 'Entrepreneurship' 2nd Edition, Oxford University Press, 2011.
4. Eric Ries, "The Lean Startup: How Constant Innovation Creates Radically Successful Businesses", Penguin, 2011
5. Rudrajeet Desai, "Breaking Out and Making Big: A No-Nonsense Book on New Age Start-Ups and Entrepreneurship", Collins, 2014

WEB REFERENCES

1. https://nptel.ac.in/courses/110/106/110106141/
2. https://nptel.ac.in/courses/127/105/127105007/
3. https://nptel.ac.in/courses/110/107/110107094/

20CS232 MANAGEMENT ESSENTIALS FOR ENGINEERS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the fundamental management concepts for the practice of a profession by an engineer.	PO2, PO3, PO11, PO12
CO2:	Understand the financial and economic aspects that are needed by an engineer for the project management.	PO2, PO3, PO11
CO3:	Apply the quantitative skills to approach the business problems and bring out better solutions.	PO2, PO3, PO11
CO4:	Apply the knowledge of generally accepted accounting principles and managerial theories in the engineering organizations.	PO2, PO3, PO11

FOUNDATIONS OF MANAGEMENT **15**

Management: Concept - Types of Business Organization - Contribution of F.W.Taylor and Henry Fayol - Organization Chart, Structure and Process; Leadership, Traits, Styles; Current Trends in Management; Functional Areas of Management

FINANCE AND ECONOMICS FOR ENGINEERS **15**

Concepts of Economics - Micro-Economics - Macro Economics - Managerial Economics - Demand and Supply Analysis- Accounting concepts and conventions - Profit and Loss Account - Balance Sheet- Sources of Finance - Working Capital Management - Crowd funding

PROJECT MANAGEMENT FOR ENGINEERS **10**

Project Planning - Application of Gantt chart -Critical Milestones Chart- Tools for Tracking - Managing Time: Variance Management and Earned Value - Managing Multiple Projects - Project Scheduling - Cost Management - Agile Project Management

Total Periods : 45

TEXT BOOKS

1. Harold Koontz and Heinz Weihrich, "Essentials of Management", Tata McGrawHill, 10th Edition, 2014.
2. Khan M.Y and Jain P.K, "Basic Financial Management", McGraw Hill, 3rd Edition, 2013.
3. M. Y. Khan and P. K. Jain, "Management Accounting: Text Problems and Cases", Tata McGraw Hill, 2013.
4. Russ J. Martinelli, Dragan Z. Milosevic, "Project Management Tool Box", Wiley Publications, 2016.
5. Salvatore and Srivastava, "Managerial Economics", Oxford University Press, 7th Edition, 2013

REFERENCES

1. Joseph L Massie, "Essentials of Management", Prentice Hall of India, 7th Edition, 2010.
2. Prasanna Chandra, "Fundamentals of Financial Management", Tata McGraw Hill, 8th Edition, 2012.
3. Pandey. I. M, "Financial Management", VikasPublishing House, 10th Edition, Reprint 2011.
4. S. N. Maheshwari, "Financial Accounting", Vikas Publishing House, 2012.
5. Clifford F. Gray, Erik W. Larson andGautam V. Desai, "Project Management", McGraw Hill, 6th Edition, 2014.

WEB REFERENCES

1. https://nptel.ac.in/courses/122/108/122108038/
2. https://nptel.ac.in/courses/109/104/109104073/
3. https://nptel.ac.in/courses/110/101/110101131/
4. https://nptel.ac.in/courses/110/107/110107081/

20CS233 WORKPLACE PROFESSIONALISM AND HUMAN VALUES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the fundamentals of psychology, behavior patterns and essential human values for every individuals in the society.	PO6, PO7, PO8, PO12
CO2:	Understand the dimensions of psychological factors that involves in every human being in an organization and in the society.	PO6, PO7, PO8, PO12
CO3:	Apply the basic professional etiquettes in everyday life for being a better employee in the organization and a responsible citizen of the society.	PO6, PO7, PO8, PO12
CO4:	Experiment with various problems faced by every individual in the society and the appropriate solution for the betterment of one's own self.	PO6, PO7, PO8, PO12

INTRODUCTION TO PSYCHOLOGY **15**

Industry and Psychology - Factors responsible for Psychology-Human Engineering- Hawthorne Studies -Mental Psychology- Organizational Psychology - Employee Motivation-Job Satisfaction and Commitment

ORGANISATIONAL PROFESSIONALISM **15**

Professional Etiquettes- Workplace courtesy- Workplace communication- Diversities in the workplace- Organizational Stress -Job Stress -Consequences - Organizational: Nature, Causes and Management

ETHICS AND HUMAN VALUES **15**

Morals, values and Ethics - Integrity - Service learning - Civic virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Cooperation - Commitment - Empathy - Self-confidence - Character - Spirituality - Yoga and meditation for professional excellence and stress management.

Total Periods : 45

TEXT BOOKS

1. Ghosh, P.K. and Ghorpade, M.B, " Industrial Psychology", Himalaya Publishers, 4th Edition,2020.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2018.

REFERENCES

1. Frank J.Landy, Jeffrey.M.Conte, "Work in the 21st Century: An Introduction to Industrial and Organizational Psychology", Wiley, 4th Edition,2013.
2. Aamodt, M.G, "Industrial Organizational Psychology: An Applied Approach", Wadsworth/ Cengage Reprint, 2008.
3. Muchinsky, P. M. "Psychology Applied to Work", Thomson, 8th Edition, 2007.
4. Singh .N, "Industrial Psychology", Tata McGraw Hill, Reprint Edition, 2011.

20EE209 PRINCIPLES OF MANAGEMENT 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Demonstrate the roles, skills and functions of management.	PO6, PO8, PO9, PO11, PO12
CO2:	Infer the importance of planning to diagnose and solve organizational problems and develop optimal managerial decisions.	PO6, PO8, PO9, PO11, PO12
CO3:	Understand the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities.	PO6, PO8, PO9, PO11, PO12
CO4:	Understand the concept of controlling and reporting	PO6, PO8, PO9, PO11, PO12

CONCEPTUAL FOUNDATION **8**

Definition of Management - Science or Art - Management and Administration - Approaches to Management - Development of Management Thought - Contribution of Taylor and Fayol - Functions of Management - Types of Business Organisations - Leadership - Types of Leadership Motivation - Hierarchy of needs - Motivation theories - Motivational Techniques

PLANNING AND ORGANISING **10**

Nature, Objectives, Types and Levels, Process of Planning, Planning Premises and Forecasting, MBO, Decision Making. Concept Organising, Forms of Organizational Structure, Combining Jobs: Departmentalization, Span of Control, Delegation of Authority, Authority & Responsibility.

STAFFING, DIRECTING AND CONTROLLING **12**

Staffing Concept; Overview of - Manpower Planning, Job Design, Recruitment & Selection, Training & Development, Performance Appraisal. Directing Concept, Direction and Supervision, Communication and Information technology. Controlling Concept, Types of Control, Controlling Techniques. Control of Overall Performance - Direct and Preventive Control - Reporting.

Total Periods: 30

TEXT BOOKS

1. Koontz. H, & Weihrich H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGraw Hills, New Delhi, 2016.
2. Ghuman K. & Aswathapa K, "Management Concepts and Cases", 10th Edition, Tata McGraw Hills, New Delhi, 2017.

REFERENCES

1. Telsan M. T., "Industrial and Business Management", 4th Edition, S. Chand, New Delhi, 2016.
2. Ramaswamy I., "Principles of Business Management", 8th Edition, Himalaya Publishing House, New Delhi, 2011.

WEB REFERENCES

1. nptel.ac.in/courses/110/105/110105146/
2. https://nptel.ac.in/courses/110/107/110107150/
3. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-mg30/

CASE STUDY

1. Management by Objectives - Super Department Stores
2. Creativity and Decision making - Tackling harassment on airlines
3. Lack of coordination in decision making - Vauxhall Helicopter Crash 2013
4. Planning and Forecasting - Easy Jet

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE210 TOTAL QUALITY MANAGEMENT 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the definition of a leader and the characteristics of a quality leader in handling the team members.	PO6, PO7, PO9, PO10, PO12
CO2:	Understand the customer perception of quality and be able to apply the concepts for customer retention during the professional career.	PO6, PO7, PO9, PO10, PO12
CO3:	Understand the implication of standards of ISO 9000 series and ISO 14000 series to the society and the environment.	PO6, PO7, PO9, PO10, PO12
CO4:	Use non-statistical and statistical tools/techniques for problem solving, grouping ideas and finding the important ones in the complex situation.	PO1, PO6, PO7, PO9, PO10, PO12

PRINCIPLES AND PRACTICES **15**

Introduction - History - Benefits of and obstacles to TQM - Leadership concepts, Deming Philosophy - Voice of customer (QFD), Customer retention - Employee Motivation, teams, performance appraisal - Juran Trilogy, PDSA cycle, Six sigma - Selection, certification and rating of suppliers - Cost of quality - Taguchi's Loss Function - Quality Management Systems (ISO 9000 series) - Environmental Management System (ISO 14000 series).

TOOLS AND TECHNIQUES **15**

Benchmarking - Tools for Quality by Design - Failure Mode Effect Analysis, the Design FMEA Document - Product safety and liability laws, prevention against liability - Management tools: affinity diagram, interrelationship digraph, tree diagram, matrix diagram - Statistical Process Control: cause and effect diagram, histogram, control charts for variables and attributes.

Total Periods: 30

TEXT BOOK

1. Besterfield and Dale H., "Total Quality Management", 3rd Revised Edition, Pearson Education, 2011.

REFERENCES

1. James R. Evans, "Total Quality Management, Organization, and Strategy", 4th Edition, Thomson Publications, 2007.
2. Besterfield D. H., "Quality Control", 7th Edition, Pearson Prentice Hall, 2004.
3. Subbaraj R., "Total Quality Management", Tata McGraw Hill Education, 2008.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/104/110104080/
2. https://nptel.ac.in/courses/110/104/110104085/
3. https://nptel.ac.in/courses/110/101/110101010/
4. https://onlinecourses.nptel.ac.in/noc21_mg03/preview

CASE STUDY

1. Toyota Corporation case study report
2. TQM and Process Improvement in Xerox
3. Apple's success and Total Quality Management tools implementation
4. A Holistic Approach to Quality Success in Tata Steel

20EE216 PROJECT AND FINANCE MANAGEMENT 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Comprehend project characteristics and various stages of a project.	PO8, PO9, PO11, PO12
CO2:	Demonstrate knowledge and understanding of project planning and implementation.	PO8, PO9, PO11, PO12
CO3:	Demonstrate knowledge and understanding of financial accounting concepts and analyze the transactions.	PO8, PO9, PO11, PO12
CO4:	Comprehend the sources of finance available for start-ups projects and entrepreneurs	PO8, PO9, PO11, PO12

PROJECT PLANNING AND IMPLEMENTATION **20**

Characteristics of projects - Definition and objectives of project management - Social relevance and national interest - Stages of project management - Defining work content, time estimation, project cost estimation and budgeting, fund raising, project risk management, project scheduling with resource constraints and planning tool - Application of Gantt Chart - Critical Milestones chart - Tools for tracking - Developing Project Plan, Resource Leveling and Resource Allocation - Time Cost Trade off - Project Implementation - Post-Project analysis and Report preparation.

FINANCIAL ACCOUNTING AND FINANCING OF ENTERPRISE **10**

Meaning, Nature and scope of financial accounting, Accounting concepts & conventions, Business Transactions, Analysis of Transactions - Need for Financial Planning, Sources of finance - Project financing - Institutional finance to Entrepreneurs - Venture Capital.

Total Periods: 30

TEXT BOOKS

1. Prasanna Chandra, "Fundamentals of Financial Management", 7th Edition, Tata McGraw Hill, 2020.
2. Shtub, Bard and Globerson, "Project Management: Engineering, Technology and implementation", Prentice Hall India.

REFERENCES

1. M.Y. Khan and P.K. Jain, "Financial Management", 8th Edition, McGraw Hill Education (India) Pvt. Ltd., 2018.
2. Ravi M. Kishore, "Project Management", McGraw Hill Education (India) Pvt. Ltd., 2007.
3. Pravin Kumar, "Fundamentals of Engineering Economics", Wiley India, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/104/110104073/
2. https://nptel.ac.in/courses/110/107/110107081/
3. https://nptel.ac.in/courses/110/101/110101131/
4. https://nptel.ac.in/courses/110/106/110106043/

CASE STUDY

1. Delhi Metro Project
2. India's Quest for Green Energy: Kamuthi Solar Project
3. Millau Viaduct: Creating an Engineering Marvel
4. Making of Aakash: The World's Cheapest Tablet
5. UIDAI's Aadhaar Project: Challenges Ahead

20EE235 POSITIVE PSYCHOLOGY 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Explain the goals and assumptions of positive psychology	PO6, PO10, PO12
CO2:	Relate positive psychology phenomena in real life	PO6, PO10, PO12
CO3:	Summarize the applications of positive psychology	PO6, PO10, PO12

INTRODUCTION2

Positive psychology: Goals and assumptions; Relationship with health psychology

POSITIVE EMOTIONS, WELL-BEING AND HAPPINESS **5**

Positive emotions: Cultivating positive emotions; Well-being: negative vs positive functions; Subjective well-being: Emotional, Social and Psychological well-being; Model of complete mental life

SELF CONTROL, REGULATION AND PERSONAL GOAL SETTING **5**

The value of self control; Personal goals and self regulation; Personal goal and well-being; goals that create self regulation; everyday explanations for self control failure problems

APPLICATIONS OF POSITIVE PSYCHOLOGY **3**

Mental health: Moving toward balanced conceptualization; Lack of developmental perspectives

Total Hours: 15

TEXT BOOKS

1. Snyder, C.R. &Lopez .S.J, "Handbook of Positive Psychology", New York: Oxford University Press, 2nd Edition, 2009.
2. Baumgardner .S .R & Crothers .M .K, "Positive Psychology", U.P: Dorling Kindersley Pvt. Ltd., 2nd Edition, 2011.

REFERENCES

1. Carr .A, "Positive Psychology, The Science of Happiness and Human Strengths", Routledge, New York, 2nd Edition, 2011.
2. Singh .A, "Behavioral Science: Achieving Behavioral Excellence for Success", Wiley India Private limited, New Delhi, 2013.

WEB REFERENCES

1. https://nptel.ac.in/courses/109/102/109102157/
2. https://nptel.ac.in/courses/109/104/109104105/

20EI210 ENGINEERING PROJECT AND FINANCIAL MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Comprehend project characteristics and various stages of a project.	PO9,PO10,PO11,PO12
CO2:	Infer the knowledge on project planning and implementation	PO9,PO10,PO11,PO12
CO3:	Familiarize with financial accounting concepts, prepare and analyse financial statements	PO9,PO10,PO11,PO12
CO4:	Summarize the sources of finance available for start-ups projects and entrepreneurs	PO9,PO10,PO11,PO12

PROJECT MANAGEMENT AND IDENTIFICATION **10**

Attributes of a Project-Project Life Cycle -Project management Process-Benefits of Project Management- Need Identification: Project Selection- Project organization- Project feasibility Analysis: Technical feasibility, commercial and financial visibility- Environment Analysis.

PROJECT IMPLEMENTATION, MONITORING AND CONTROL **15**

Project representation: Role of project managers, relevance with objective of organization, preliminary manipulations -Basic Scheduling concepts : Resource levelling, Resource allocation, Setting a base line- Project management information system- Importance of contracts in projects -Team work in Project Management- Formation of Effective terms.

FINANCIAL MANAGEMENT **12**

Financial Accounting Concepts and Conventions - Preparation and Analysis of Financial Statements : Profit & Loss Account and Balance Sheet - Sources of Finance : Long Term Sources, Term Loans and Working Capital Advances - Break even analysis.

ENTREPRENEURSHIP **08**

Entrepreneurship and Economic Development - Classification and Types of Entrepreneurs - Traits and Qualities of a successful Entrepreneur -The Entrepreneurial Process - Role of Entrepreneurial-Institutions in Entrepreneurship Development-Various Schemes and Incentives-Venture Capitalists

Total Periods: 45

TEXT BOOKS

1. Prasanna Chandra, "Fundamentals of Financial Management", 8th Edition, Tata McGraw Hill, 2017.
2. Project Management Institute "A Guide to the Project Management Body of Knowledge", PMBOK Guide, 6th Edition, 2017

REFERENCES

1. M.Y. Khan and P.K. Jain, "Financial Management", 7th Edition, McGraw Hill Education (India) Pvt. Ltd., 2017.
2. Ravi M. Kishore, "Project Management", McGraw Hill Education (India) Pvt. Ltd., 2007.
3. Pravin Kumar, "Fundamentals of Engineering Economics", Wiley India, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/112/107/112107238/
2. https://nptel.ac.in/courses/110/107/110107141/
3. https://nptel.ac.in/courses/110/106/110106045/

20EI211 PLANNING AND ORGANIZATIONAL BEHAVIOR 3 0 0 3

Course Outcomes

CO1:	Infer the importance of planning and it's effective application at work place to diagnose and solve organizational issues.	PO10,PO12
CO2:	Demonstrate and apply the concepts of organizational behaviour to understand the behaviour of people in the organization.	PO8, PO9, PO10, PO12
CO3:	Analyze the role of personality and demonstrate the ability to build strong personality attributes.	PO6, PO9, PO10, PO12
CO4:	Evaluate the various leadership styles and apply the appropriate styles at different corporate situations.	PO9, PO10, PO12

On successful completion of the course, students will be able to

PLANNING **10**

Nature and Purpose of Planning -Steps in Planning - Types of Planning - Objectives - Setting objectives - Policies - Planning Premises - Planning Tools and Techniques.

ORGANIZATIONAL BEHAVIOR **12**

Introduction - Key Determinants - Multidisciplinary Roots of OB - OB Models - Emerging Challenges and Opportunities for OB - Emotional Intelligence - Motivation Theories - Conflicts and Negotiation.

PERSONALITY AND BEHAVIOR **13**

Personality and Individual Differences: Determinants of Personality - Major Personality Attributes influencing OB - The Big Five Model, MBTI Theory - Theories of Personality - Well-Being: Positive Psychology, Mindfulness, Happiness Factor, Meaningfulness, Positives and Negatives.

LEADERSHIP AND BEHAVIOR **10**

Leadership Theories - Types and different styles of Leader - The New Reality for Leaders - Skills and Competencies - Women and Leadership - Best practices of Leadership - Entrepreneurial Traits and Behaviours.

Total Periods: 45

TEXT BOOKS

1. Stephen P.Robbins, Timothy A. Judge, Neharika Vohra, "Organisational Behaviour", PHI Learning Pearson Education, 16th Edition, 2017.
2. Harold Koontz and Heinz Weihrich, "Essentials of Management", 2nd edition 2015.

REFERENCE BOOKS

1. L.M.Prasad, "Principles and Practices of Management", Sultan Chand & Sons, 1st Edition, 2014.
2. Fred Luthans, "Organisational Behaviour", McGraw Hill, 12th Edition, 2014.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105033/
2. https://nptel.ac.in/courses/110/105/110105146/

20EI219 LEADERSHIP EXCELLENCE AND DEVELOPMENT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Illustrate about positive outlook and critical thinking	PO9, PO10, PO11,PO12
CO2	Build the team work and leadership skills	PO9, PO10, PO11,PO12
CO3	Develop the communication and personality skills	PO9, PO10, PO11,PO12
CO4	Recognize the networking and interpersonal skills	PO9, PO10, PO11,PO12
CO5	Interpret the entrepreneurialleadershiprequirements	PO9, PO10, PO11,PO12

GROWTH MINDSET AND CREATIVE EYE **2**

Developing Habit - Overcoming Self-LimitingBeliefSystem - Being & Doing Positive - Branding - Think out of Box - Critical Thinking

LEADERSHIP **2**

Basics of Leadership - Type of Leadership - Road Ahead-Dream & Destination - Case Study

TEAM BUILDING **2**

Basics of Team - Building a Good Team - Success recipe for Good Team - Group Team Discussion

INTRAPERSONAL COMMUNICATION **2**

Changing Negative Self- Talk to Positive - Managing Overthinking

EMOTIONAL INTELLIGENCE & PERSONALITY DEVELOPMENT **2**

Know Yourself - Control Yourself - Empower Yourself - Time Management - Dressing for Success

NETWORKING & PEOPLE SKILLS **2**

Interpersonal Skills - Assertiveness - Negotiation Skills - Problem Solving - Decision Making - Persuasiveness

ENTREPRENEURIAL SKILL **5**

Frame work for entrepreneurial leadership requirements - Personalized Assessment of entrepreneurial orientation - Explore top competencies and Behaviors of successful Entrepreneurial leaders - Gain insight into what distinguishes Entrepreneurial Leaders from Traditional leaders - Evaluate the gaps that exist between Self-Perception versus Actual Results - Look at Leadership Characteristics that contribute to being an effective leader - Examine Four Key Success Factors and Attributes that Entrepreneurial leaders exhibit - Highlight top Influences that drive Entrepreneurial leaders to take- action - Engage in a discussion about the Challenges and Opportunities leaders face - Ask participants to Identify Gaps and areas needing further development - Put in place Individual Action Plans for each participant moving forward - Assess the Entrepreneurial Orientation at the team, group or organization level - Include Exercises and Stories of successful Entrepreneurial leaders

Total Periods: 17

20HS201 ADVANCED BUSINESS ENGLISH 3 0 0 3

PRE REQUISITE

20HS270 Preliminary Business English

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1:	Choose the vocabulary to communicate in profession and business world.	PO10, PO12
CO2:	Extend the use of listening and reading skills to comprehend effectively.	PO9, PO10, PO12
CO3:	Illustrate the skills required to participate in conversations and to deliver oral presentations.	PO9, PO10, PO12
CO4:	Develop professional writing skills to be used for various activities.	PO10, PO12

GRAMMAR AND VOCABULARY **10**

Sentence Pattern - Articles - Determiners - Phrasal Verbs - Idioms and Phrases - One word substitution - Collocations- Spotting Errors - Describing Cause and Effect - Framing Question and Answers -Vocabulary related to Teamwork, Hotels, Corporate Companies, Job Responsibilities, Financial Terms, Marketing and Ethical Banking, Health and Safety, Business Expenses, Business Travel, Staff Appraisal, Marketing Disasters and Global Marketing.

READING AND LISTENING **15**

Listening for writing short answers: Telephone conversation - identifying topic, context, function - Extended conversation or monologue; interview, discussion, presentation - formal and informal conversation.

Reading: Understanding text structure, Skimming and Scanning, Vocabulary and structure information, understanding sentence structure/error identification- Articles on: teamwork, making arrangements, choosing a hotel, Ways of entertaining business clients, arranging a company visit.

SPEAKING **10**

Giving personal information: talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Expressing and justifying opinions, Speculating, Comparing and Contrasting, Agreeing and Disagreeing- Role Play - Giving Directions - Discussion: current affairs, company's growth, Job benefits, Promoting companies at trade fairs, Presentation, Group Discussion, Making suggestions.

WRITING **10**

Giving Instructions: explaining a development, asking for comments, requesting information-agreeing to requests- Report and Proposal - Completing a business report- Correspondence Internal and External : Explaining, Apologizing, Reassuring, Complaining, Promotional - Recommending, persuading- Interpreting Charts and Diagrams - Paragraph writing :Compare and Contrast - Paraphrasing- Job Description- Product Description- Dangers of Plagiarism-

Preparation and presentation of Technical paper as per standard IEEE format using plagiarism Software.

Total Hours: 45

TEXT BOOKS

1. "Cambridge English: BEC Vantage with answers", 1st edition. Cambridge University Press, New Delhi, 2016.
2. "Cambridge English: Business Benchmark Pre-intermediate to Intermediate Business Preliminary", 2nd edition. Cambridge University Press, Noida, 2014.

REFERENCES

1. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage", 2nd edition, Cengage Learning, New Delhi, 2014.
2. Gerson, Sharon.J Steven M.Gerson, "Technical Writing - Process and Product", 3rd edition, Pearson Education (Singapore) (P) Ltd., New Delhi, 2009.
3. Murcia Marianne Celce, Donna M.Brinton and Marguerite Ann Snow, "Teaching English as a Second or Foreign Langauge", 4th edition, National Geographic Learning, a part of Cengage Learning, New Delhi, 2014.

WEB REFERENCES

1. www.cambridgeenglish.org/learning-english
2. www.facebook.com/cambridgeenglish.
3. www.cambridgeenglishonline.com
4. www.writeandimprove.com
5. BEC Orientation App

ENLIGHTENMENT THROUGH EDUCATION SREC

20HS202 TECHNICAL WRITING 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Recall the scientific and technical communication in the workplace for effective collaboration.	PO10, PO12
CO2:	Illustrate technical information and knowledge in practical documents for professional audiences.	PO9, PO10, PO12
CO3:	Develop the unique qualities of professional writing style in letters/ Emails and Instructions.	PO9, PO10, PO12
CO4:	Demonstrate proof reading and editing skills through usage of coherent, concise and appropriate sentences.	PO10, PO12

TECHNICAL WRITING **15**

The writing process: pre-writing, writing, rewriting - words often confused- frequently asked questions in interview- Process of writing project report-Graphical representations-Punctuation- Bibliography- Dangers of Plagiarism.

TECHNICAL DOCUMENTS **20**

Format of writing Thesis, Preparing Abstracts, article - Email Correspondence - Editing for Style - Instructions and Recommendations - Procedures and Policies in Describing and Summarizing Technical Information - Small group meetings: brainstorming, collaborating on writing projects - Preparation and presentation of Technical paper as per standard IEEE format using plagiarism Software - Ethics in writing.

EDITING AND PROOF READING **10**

Resume (Cover letter and Curriculum Vitae), Statement of purpose, Professional and Business Letters, Letter to the editor- Error correction, Meeting: preparing Agenda, Minutes and Memos - Professional Presentations - Style in technical writing.

Total Hours: 45

TEXT BOOKS

1. Konar, Nira. "Communication Skills for Professionals", 1st edition, PHI Learning Private Limited, New Delhi, 2011.
2. Anderson. Paul.V. "Technical Communication", 8th edition, Cengage Learning India, Pvt. Ltd., New Delhi, 2014

REFERENCES

1. Basu, B.N. "Technical Writing", 1st edition, PHI Learning, New Delhi, 2007.
2. Bailey, Stephen. "Academic Writing: A Practical guide for students", 1st edition, London, Routledge, 2004.
3. Rizvi, Ashraf M, "Effective Technical Communication", 5th edition, Tata McGraw Hill, New Delhi, 2008

WEB REFERENCES

1. www.writeandimprove.com
2. https://nptel.ac.in/courses/109/106/109106094/
3. https://medium.com/technical-writing-is-easy/free-technical-writing-ebooks-c7662b213af1

20HS203 BASIC GERMAN 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Relate the German Language to Culture, Food and Nationality.	PO10, PO12
CO2:	Illustrate the structure of German language and its Grammar.	PO10, PO12
CO3:	Explain the concept of time using verbs and tenses.	PO9, PO10, PO12
CO4:	Develop simple sentences for basic conversation.	PO9, PO10, PO12

GERMAN CULTURE **10**

Tradition- Universities and Companies- Places in a City Greetings-Countries, Food, Shopping and preferences in Food, Friends-Family and Profession, Nationalities and Languages- Hobbies.

BASIC GRAMMAR **20**

Wh-Questions- Definite Article-Irregular Verbs and Personal Pronouns, Irregular verbs-modal verbs and Sentence formation, Number system, Question words, Statements and Questions, Negation: nicht/kein, Imperatives, Alphabets-Numbers- Personal pronouns and basic verbs - Yes/No questions- Indefinite Article and Negation Article, Time-Akkusative cases, verbs with Akkusative, time information.

SPEAKING AND WRITING **15**

Self-Introduction - Questions and Answers regarding places - finding way to places, Simple Dialogues Exercises, Questions and answers with time, arranging an unofficial appointment and Profession arranging an in official appointment and excuse for a delay.

Total Hours: 45

TEXT BOOKS

1. Dengler, Stefanie, et al, "Netzwerk A1". 1st edition, Klett-Langenscheidt Gmbh, München, 2013.
2. Evans,Sandra, et al, "A1- Hueber". 1st edition, Verlag, 2012.

REFERENCES

1. Funk,Hermann, et al, "Studio d A1".1st edition, Goyal Publishers and Distributors Pvt. Ltd, 2009.
2. Dallapiazza, Rosa-Maria, et al, " Tangram Aktuell 1 (Deutsch als Fremdsprache) ". 1st edition, Max Hueber Verlag, 2004.

WEB REFERENCES

1. https://www.goethe.de/en/index.html
2. https://learn-german-easily.com/index-basic-german
3. https://www.deutsch-lernen.com/learn-german-online/beginners/summary.php
4. https://www.studying-in-germany.org/learn-german/

20HS204 **BASIC JAPANESE** **3 0 0 3**

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Recall the Japanese script and alphabet without errors.	PO10, PO12
CO2:	Extend the conversation using basic sounds in Japanese language.	PO9, PO10, PO12
CO3:	Explain the concept of time by learning verbs, tenses and vocabulary.	PO9, PO10, PO12
CO4	Make use of appropriate vocabulary required for simple conversation in Japanese language.	PO9, PO10, PO12

JAPANESE ALPHABET **15**

Japanese script - Pronunciation of Japanese(Hiragana), (Katakana) - Long vowels - Pronunciation of in, tsu, ga - Letters combined with ya, yu, yo - Daily Greetings and Expressions - Numerals. N1 wa N2 desu - N1 wa N2 ja arimasen - S ka - N1mo - N1 no N2 - san - Kore - Sore - Are - Kono N - Sono N - Ano - N - Sou desu - Souja Arimasen - S1 ka - S2 ka - N1 no N2 - Sou desu ka - Koko - Soko - Asoko - Kochira - Sochira - Achira - Ni wa N2 (place) desu - Doko - Dochira - N1 no N2 - Ko - So - A - Do (Demonstrative words) - O kuni - Kanji10 - Technical Japanese Vocabulary (30 Numbers).

CONCEPT OF TIME **15**

Ji - Fun - Pun - Introduction of verbs - V Masu - V Masu - V Masen - V Mashita - V Masendeshita - N (Time) Ni V - N1 Kara - N2 Made - N1 to N2 - S Ne - N (Place) e Ikimasu - Kimasu - Kaerimasu - Doko (e) Mo Ikimasen - Ikimasendeshita - N (Vechile) de Ikimase -Kimasu - Kaerimasu - No (Person / Animal) to V - Itsu - S Yo -N o (transitive) - N o Shimasu - Nani o Shimasuka - Nan and Nani - N (place) de V - V Masenka - V Mashou - o - Kanji 10 - Technical Japanese Vocabulary (30 Numbers).

BASIC GRAMMAR **15**

N (tool/means) de V - Word/Sentence wa Go de Nani desu ka - N (person) Ni Agemasu, etc - N (person) Ni Moraimasu etc - Mou V Mashita - Introduction to Adjectives.

Total Hours : 45

TEXT BOOKS

1. Yoshiko, Isuruo, et al, "Minna no Nihongo". 1st edition, 3A Corporation, Tokyo, March 2001.
2. Kazuko, Karasawa, et al, " Nihongo Challenge". 1st edition, Ask publishing, Japan, 2010.

WEB REFERENCES

1. www.japaneselifestyle.com
2. www.learn-japanese.info/
3. www.kanjisite.com/
4. www.learn-hiragana-katakana.com/typing-hiragana-characters/

20HS270 PRELIMINARY BUSINESS ENGLISH 2 0 2 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Choose effective listening and speaking skills by means of rhetorical functions	PO10, PO12
CO2:	Extend reading and writing skills for professional business communication	PO9, PO10, PO12
CO3:	Demonstrate the art of speaking and writing through the appropriate usage of Grammar and Vocabulary	PO9, PO10, PO12
CO4:	Build communication through the four major skills of language learning.	PO10, PO12

AUDITORY & ORATORICAL SKILLS

LISTENING **8**

Describing jobs and its responsibilities- Telephonic Conversation- Company / Product description - Describing dimensions of product - Office etiquette-Recruitment procedures-Short conversations and monologues - Interview / discussion between two or more people- Listening for specific information

SPEAKING **10**

Self Introduction- General interaction and social language- Expressing opinion agreeing and disagreeing- Demonstrating job, company status, explaining games - Person Concerned (Business) - Company profile- Vocabulary development- Role play- Annual Sales report- Comments on articles - Picture description- situational conversation (working in pairs) - Advertisements

COMPREHENSION & ANALYTICAL SKILLS

GRAMMAR & VOCABULARY **8**

Parts of Speech- Tenses- Subject Verb Agreement - Reasons and Consequences- Degrees of Comparison- Framing Questions- Conditional Clauses- Short messages - Vocabularies related to banking, interview, business equipments, Hotel, traffic and transport.

READING **9**

Reading Comprehension- Grammatical accuracy and understanding of text structure- Formal and Informal conversations- Reading Short texts: memos, understanding short real world notices -Reading for gist and specific information- Interpreting visual information - Reading and transfer information- Cloze Reading

WRITING **10**

Email etiquette and Email Writing- Fax -Memos- Process Description - Sequencing words -Arranging appointments- Asking for permission- Giving Instructions- Letter writing - Check list -Job Application- Telephone etiquette - Recommendations - Preparing Agenda and Minutes- Internal and External Communication - Formal and Informal writing.

Total Hours: 45

TEXT BOOKS

1. Cambridge English: BEC Preliminary with answers. Cambridge University Press, New Delhi 2016.
2. Wood Cambridge University, "Business Benchmark Pre-intermediate to Intermediate Business preliminary", second edition Cambridge University Press, Noida, 2014.

REFERENCES

1. Ian wood, Anne Williams with Anna Cowper, "Pass Cambridge BEC Preliminary", 2nd edition, Cengage Learning, 2015.
2. Dr.K.Rathnasabapathi, "Dynamics of Communication Skills in English through situational approach", 1st edition, 2016.
3. Murcia Marianne Celce, Donna M. Brinton and Marguerite Ann Snow, "Teaching English as a Second or Foreign Langauge", 4th edition, National Geographic Learning, a part of Cengage Learning, 2014.

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2. www.facebook.com/cambridgeenglish.
3. www.cambridgeenglishonline.com
4. www.writeandimprove.com

ENLIGHTENMENT THROUGH EDUCATION SREC

20IT203 LIBERAL ARTS - WEB DESIGN 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the basic concepts of web design.	PO1, PO2, PO3, PO12
CO2:	Design and build websites using HTML5 and CSS3.	PO2, PO3, PO5, PO12

GETTING STARTED WITH WEB DESIGN BASICS AND HTML5 **7**

Introduction to Impressive Web design - Guidelines for creating Impressive Web Page design -Examples on top most award winning Website designs - How the Web works - Structure of a Web Page - Role of Web design in e-Publishing - Introduction to HTML5 and its features - Structural Tags - Formatting Text - Creating Tables and Lists - Adding Links - Working with Forms and Controls - Embedding Multimedia elements and Images.

EXPLORING CSS3 **8**

Introduction to CSS3 - Embedding CSS in HTML document - Selectors - Formatting Text - Colors and Backgrounds - Box model - Positioning and Layout - Transitions, Transforms and Animations - Responsive Web design.

Total Hours: 15

TEXT BOOKS

1. Jennifer Robbins, "Learning Web Design", 5th Edition, 2018, O'Reilly Media, Inc.
2. Thomas A. Powell, "HTML & CSS: The Complete Reference", 5th Edition, 2010, McGraw Hill.

REFERENCES

1. Terry Felke-Morris, "Web Development and Design Foundations With Html5", 9th Edition 2019, Pearson India.
2. Elizabeth Castro, Bruce Hyslop, "HTML5 and CSS3", 7th Edition 2012, Peachpit Press.
3. Andy Chong, "Basics Animation: Digital Animation", 1st Edition 2007, AVA Publishing.

20IT209 ENTREPRENEURSHIP DEVELOPMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the concept and overview of entrepreneurship with a view to enhance entrepreneurial talent.	PO2
CO2:	Apply the knowledge on the basics of entrepreneurial skills and competencies with necessary inputs for creation of new ventures.	PO3, PO4
CO3:	Develop business plan, explain operational implementations for project management and to generate innovative business ideas.	PO7, PO12

INTRODUCTION TO ENTREPRENEURSHIP **15**

Concept and overview of Entrepreneurship - Evolution and Growth of Entrepreneurship in India - Role of Entrepreneurship in Economic development - Emerging models of corporate entrepreneurship - Entrepreneurial Culture - Entrepreneurial Society - Entrepreneurship Development Programs - Problems and Challenges of Entrepreneurs - Entrepreneurial Scenario in India.

INTRODUCTION TO TECHNOLOGY INNOVATION & STARTUPS **15**

Idea versus opportunity - Sources of ideas and opportunities - identification - Evaluation and selection of opportunities - Innovation and its forms - Myths and realities - Understanding the process - Product Development Cycle - Management of Technological Innovation - Technology Fusion and the new R&D - New age Startups - Business Incubation Centres - Start-up policy framework and incentives.

BUSINESS PLAN AND FINANCING **15**

Business Plan - Meaning, Scope and Need - Financial, Marketing, Human Resource and Production/Service Plan - Business plan Formats - Financial opportunity identification - Banking sources - Non-banking Institutions and Agencies - Venture Capital - Meaning and Role in Entrepreneurship - Government Schemes for funding business - Pre launch, Launch and Post launch requirements - Procedure for getting License and Registration - Challenges and Difficulties in Starting an Enterprise.

Total Hours: 45

TEXT BOOKS

1. Khanka. S.S., "Entrepreneurial Development", S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
2. Donald F Kuratko, "Entrepreneurship - Theory, Process and Practice", 9th Edition, Cengage Learning 2014.

REFERENCES

1. Hisrich R D, Peters M P, "Entrepreneurship", 8th Edition, Tata McGraw-Hill, 2013.
2. Mathew J Manimala, "Entrepreneurship theory at cross roads: paradigms and praxis" 2nd Edition, Dream tech, 2005.
3. Rajeev Roy, "Entrepreneurship", 2nd Edition, Oxford University Press, 2011.
4. Eric Ries, "The Lean Startup: How Constant Innovation Creates Radically Successful Businesses", Penguin, 2011.
5. Rudrajeet Desai, "Breaking Out and Making Big: A No-Nonsense Book on New Age Start-Ups and Entrepreneurship", Collins, 2014.

20IT210 **PROJECT MANAGEMENT** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Interpret and apply the concepts of project identification and analysis.	PO2
CO2:	Acquaint with the knowledge on project appraisal, planning and scheduling techniques.	PO3, PO4
CO3:	Review and evaluate progress on of project and apply project management and controlling techniques.	PO5
CO4:	Develop the skills and techniques of a successful negotiator.	PO9, PO12

INTRODUCTION TO PROJECT MANAGEMENT **10**

Project Management - Definition - Goal - Phases of a Project - Project Life Cycle - Primary project constraints - Roles and responsibilities of the project manager - Project Identification and Analysis - Generation and Screening of Project Ideas - Forms of Project Organization.

PROJECT PLANNING AND ANALYSIS **10**

Techniques of Project Appraisal - Market Demand Analysis - Technical Analysis - Project Planning stages - Project financing - Sources - Role of Financial Institutions in Project Financing - Project Planning and Scheduling.

PROJECT EVALUATION AND CONTROL **15**

Project Evaluation: Objectives- Methods-Phases and Types of Post Audit-Computer Aided Project Management and future of Project Management-Agile Project Management - Project Monitoring and Control - Control Techniques - Concept of Time and Cost Overrun- Managing Project Risk - Project Closure.

NEGOTIATION MANAGEMENT **10**

Negotiation - Introduction - Definition - Benefits - Negotiation skills - Negotiation Process - Negotiation lifecycle- Negotiation During the Project Life Cycle - Rules of Negotiation - Power And Politics - Negotiating Collaboratively - Project Constraints During Negotiation.

Total Hours: 45

TEXT BOOKS

1. Nagarajan, "Project Management", New age International Publishers, 6th Edition, 2012.
2. Russ J.Martinelli, Dragan Z.Milosevic, "Project Management Toolbox", Wiley, 2nd Edition, 2016.

REFERENCES

1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Tata McGraw Hill, 8th Edition, 2014.
2. Joseph Phillips, "IT Project Management: on track from Start to Finish", Tata McGraw Hill, 2nd Edition, 2008.
3. James Lewis, "Project Planning, Scheduling and Control", Tata McGraw Hill, 5th Edition, 2010.
4. James P. Clements and Jack Gido, "Effective Project Management", Cengage Learning, 3rd Edition, 2009.
5. Jack R. Meredith and Samuel J. Mantel, "Project Management - A Managerial Approach", Wiley, 8th Edition, 2015.

20IT218 WOMEN DEVELOPMENT AND EMPOWERMENT

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Learn about diverse approaches to Gender Development.	PO8, PO12
CO2:	Sensitize about gender parity and women empowerment.	PO8, PO12
CO3:	Impart knowledge on Gender issues and laws.	PO8, PO12

WOMEN'S EMPOWERMENT AND GENDER PARITY **7**

Women and Gender Equality- Gender Sensitization- Status of women in Vedic Era- The Role of the United Nations in Universal Women's Empowerment- The Gender Role in Sustainable development (Feminism & Power)- Women and Leadership- Empowerment through Women's Education- Role of Women Entrepreneurs in India

GENDER INCLUSIVE APPROACHES AND LAW **8**

Different Approaches to Development - Women in Development (WID) - Women and Development (WAD) - Gender and Development (GAD) - Millennium Development Goals in India - Contemporary Gender and Health Issues- Personal laws for women- Criminal Laws for women-Right to self-defence.

Total Hours: 15

TEXT BOOKS

1. Adv. SanjivNarang, "Laws for Women in India", 2021.
2. Dr.ShikhaBhatnagar, "Women's Empowerment & Gender Equity", Notionpress, 2020.
3. Dr.AnujaMahapatra and Prof.SukhadebNaik, "Crime against Girls and Women: Global Perspective and Challenges", New Delhi, Enkay Publishing House, 2013.
4. Ed,Wendy Harcourt, "The Palgrave handbook on Gender and development", Palgrave Macmillan, 2016.
5. TambeAngha, "Development Gender Perspective", KrantijotiSavitribaiPhule Publication, Women's Studies Centre, SavitribaiPhule Pune University, Pune, 2010.

REFERENCES

1. Nirmala Banerjee, Samita Sen and Nandita Dhawan,"Mapping the Field: Gender Relations in Contemporary India", Kolkata: School of Women's Studies, Jadavpur University, 2012.
2. Veltmeyer Henry (ed.), "The Critical Development Studies Handbook: Tools for Change", Fernwood Publishing, 2011.
3. Boserup, Ester, "Woman's Role in Economic Development", London,2010.
4. Dr.AnujaMahapatra and Prof.Sukhadeb Naik, "Crime against Girls and Women: Global Perspective and Challenges", New Delhi, Enkay Publishing House,2013.

20RA212 WORK SYSTEM ENGINEERING AND ETHICS 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Demonstrate the understanding of work system design by work study techniques	PO1, PO6, PO7
CO2:	Distinguish the manual and computer process planning methods used in modelling	PO1, PO6, PO7
CO3:	Summarize the concepts of production planning and control for industrial automation	PO1, PO6, PO7
CO4:	Explain the concepts of industrial ergonomics in man -machine automation	PO1, PO6, PO7
CO5:	Recognize concepts of ethics and moral values in engine ering industries	PO1, PO6, PO7

WORK SYSTEM DESIGN **15**

Productivity - Definition - reasons for low productivity - methods to improve productivity

Work Study: Basic Concept - Steps Involved in Work Study - Concept of Work Content - Techniques of Work Study - Human Aspects of Work Study.

Method Study: Objectives - basic procedure - Various recording techniques: Process charts - multiple activity charts - SIMO chart - flow diagram - string diagram - Principles of motion economy

Work Measurement: Purpose - basic procedure - various techniques of work measurement - Stop watch - time study

PROCESS AND PRODUCTION PLANNING **15**

Process Planning: Definition - Objective - Scope - Approaches to process planning - Manual Process Planning - Computer Aided Process Planning (CAPP) - Retrieval and Generative Model.

Production Planning and Control: Functions of production planning and control - Types of production systems - Routing - Loading and scheduling - Different methods of scheduling - Expediting - Dispatching

Ergonomics: Basic Concept - Industrial Ergonomics - Ergonomics: Anthropometry - Man-Machine System-1 - Man-Machine System-2 - Case Study of Assembly Line Worker

ENGINEERING ETHICS **15**

Definition of ethics - Morals values and ethics - integrity-Work ethics - Variety of moral issues - Moral dilemmas - Moral Autonomy - Theories about right action - Self-interest

Engineering as Experimentation - Engineers as responsible Experimenters - Codes of Ethics - Safety and Risk - Assessment of Safety and Risk - Risk Benefit Analysis and Reducing Risk - Respect for Authority - Conflicts of Interest - Occupational Crime - Professional Rights - Employee Rights - Intellectual Property Rights (IPR) - Discrimination

Multinational Corporations - Environmental Ethics - Computer Ethics - Engineers as Managers - Consulting Engineers - Engineers as Expert Witnesses and Advisors - Moral Leadership - Code of Conduct - Corporate Social Responsibility

Total Hours: 45

TEXT BOOKS

1. Panneerselvam.R, "Production and Operations Management", Prentice Hall of India Pvt. Ltd, 3rd Edition, 2012.
2. Mike Martin and Roland Scherzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.

REFERENCES

1. Khan.M.I, "Industrial Engineering", New Age International Publishers, 1st Edition, 2004.
2. Philip.E.Hicks, "Industrial Engineering And Management: A New Perspective", McGraw-Hill, 3rd Edition, 2007.
3. Govindrajan.M, Natarajan.S, SenthilKumar.V.S, "Engineering Ethics", Prentice Hall of India,Newdelhi,2004.
4. Charles D.Fledermann, "Engineering Ethics", Pearson Education / Prentice hall, New jersey,2000

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2. http://nptel.ac.in/courses/112107142/
3. http://nptel.ac.in/courses/112105126/26

ENLIGHTENMENT THROUGH EDUCATION SREC

20RA217 ECONOMICS FOR ROBOTICS AND AUTOMATION 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Describe the basics of economics, law of demand and supply.	PO1, PO7
CO2:	Perform and evaluate capital investment alternatives and cost analysis in manufacturing	PO1, PO7
CO3:	Perform the economics analysis of robot and cost consideration in automation	PO1, PO7
CO4:	Summarize the implementation phase and selection of tools in robotics and automation	PO1, PO7

ECONOMIC ANALYSIS- METHODS **9**

Law of supply and demand - Concept of Engineering Economics - Engineering efficiency - Some economic concepts - Value and utility - Interest and Interest rate - Time value of money - Interest formulas: Simple and compound interest - Cash flow diagrams - Replacement and Maintenance Analysis - Depreciation

PRODUCTION ECONOMICS AND COST ANALYSIS **12**

Production economics - Elements of economic analysis - sensitivity analysis - Methods of Evaluating Capital Investment Alternatives - Costs in Manufacturing - Elements of Cost - Break-Even Analysis -Make or buy decision - Unit cost of production - Cost of Manufacturing - Lead time and Work-in-process - Different costing methods - product life cycle cost analysis - Tools and techniques

ECONOMIC ANALYSIS OF ROBOTS AND AUTOMATION **15**

Type of robot installation - cost data required for the analysis - Methods of Economic analysis - Payback - ROI - EUAC - Cash flow method - problems - subsequent uses of robot - Difference in production rates - other factors - Robot project analysis form.

Cost considerations in Industrial Automation - Procurement and deployment - Operations and maintenance - End-of-Life (EOL) management - Monte carlo method

IMPLEMENTING ROBOTICS AND AUTOMATION **9**

Familiarization with robotics and automation technology - plant survey to identify potential applications - Selection of the best applications - Selection of a robot and automation tools - detailed economic analysis - planning and installation

Total Hours: 45

TEXT BOOKS

1. Mikell P. Groover, Mitchell weiss, Roger N. Nagel, Nicholas G.Odrey, Ashis Dutta, "Industrial Robotics 2e-Technology, Programming and Applications ", McGraw Hill, 2012
2. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, 2001.

REFERENCES

1. Riggs.J.L, Engineering Economy, 4th edition, McGraw Hill, 2002
2. Richard D. Klafter, Thomas. A, Chri elewski, Michael Negin, "Robotics Engineering an Integrated Approach", Prentice Hall of India Pvt. Ltd., 1989
3. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and Analysis", Engg. Press, Texas, 2002.
4. Degarmo E.P., Sullivan W.G and Canada J.R, "Engineering Economy", Macmillan, 1984

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1. https://nptel.ac.in/courses/112/107/112107209/#

20MA209 VEDIC MATHEMATICS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Enhance mental agility and intelligence.	PO1, PO2
CO2:	Solve complex mathematical calculations mentally.	PO1, PO2

High Speed Multiplication, Faster Division, Algebra: Linear, Simultaneous, Quadratic and Miscellaneous Equations, Accelerated Addition, Instant Subtractions, Squares Cubes, Square Roots, Cube Roots, Digital Roots, Math Meditation - Doing Math Calculations without Pens and Paper, Divisibility, Calendars, Pythagoras Theorem, Recurring Decimals, Determinants, Triples, Coordinate geometry, Calculus.

Total Hours: 15

REFERENCES

1. Vedic Mathematics by Jagadguru Swami Sri Bharati Krishna Tirthaji Maharaja (MLBD) January 2018
2. The Power of Vedic Maths by Atul, Jaico Publishing Company,2011
3. Vedic Maths - 1 by H.K.Gupta S.Chand (G/L) & Company Ltd; 3rd edition 2008

20ME226 INTRODUCTION TO ROBOTICS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Outline the configuration and architecture of robotics.	PO1
CO2	Summarize the subsystems of industrial robots	PO1
CO3	Explain the applications of industrial robots	PO1, PO12
CO4	Describe the legged and wheeled mobile robots used for locomotion.	PO1

Overview of Robotics **6**

Evolution - Classification - Laws of Robotics - Structure and Configuration, Characteristics, Components of Robots and General Architecture - Development Trends in Robotics.

Industrial Robots and their Applications **12**

Robot subsystems - Robot Vision - Artificial Intelligence - Industrial Automation - Underwater Robots - Flying Robots - Robots in Painting, Gluing, Handling, Tending, Hemming, riveting, laser cutting and Welding.

Autonomous mobile robots **12**

Locomotion - key issues for locomotion, legged mobile robots, leg configurations and stability, examples of legged robot locomotion, wheeled mobile robots, wheeled locomotion-the design space, wheeled locomotion: case studies.

Total Periods: 30

TEXT BOOKS:

1. Robotics, Appin knowledge solutions, Infinity Science Press LLC, Hingham, Massachusetts, New Delhi 2007.
2. R.K.Saha - Introduction to Robotics - McGraw Hill Education (India) Private Limited, New Delhi, 2014.
3. Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots, Second Edition", MIT Press, 2004.

REFERENCE BOOKS:

1. H.F. Davidson, Lester Gerhardt, Michael Brady, Robotics and Artificial Intelligence, Springer Berlin Heidelberg, 2012
2. Mordechai Ben-Ari, Francesco Mondada, Elements of Robotics, Springer International Publishing, 2017.

20ME218 TOTAL QUALITY MANAGEMENT 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Outline the TQM principles and the essential concepts for the implementation of effective quality management system	PO1, PO2, PO6, PO7, PO12
CO2	Apply the various statistical process control tools to control the quality of the process and product	PO1, PO2, PO6, PO7, PO12
CO3	Make use of TQM strategies for continuous process improvement	PO1, PO2, PO6, PO7, PO12
CO4	Organize various TQM techniques like QFD, TPM and FMEA for organizational excellence	PO1, PO2, PO6, PO7, PO11, PO12
CO5	Illustrate the features of Quality Management System and Environmental Management System	PO1, PO2, PO6, PO7, PO12

TQM PRINCIPLES AND ESSENTIALS **10**

Definition of quality, Dimensions of quality, need for quality, Evolution of quality, Contributions of TQM gurus, Factors affecting quality, Quality planning, Quality costs and Benefits of TQM. The Deming philosophy, Barriers to TQM implementation.

TQM leadership - Leadership characteristics and Habits of effective leaders. Customer satisfaction - Types of customer- Customer perception of quality, Kano model, Customer retention, Supplier partnership - Employee involvement - Motivation, Empowerment and Team work

STATISTICAL PROCESS CONTROL FOR TQM **6**

Seven quality control tools, Statistical methods for quality improvement, Process control -Control charts for variables - X, R charts and Control charts for attributes - np and c charts. Concept of process capability, and New seven management tools.

TQM STRATEGIES **5**

Continuous process improvement - Juran Trilogy, PDSA cycle, Kaizen, Benchmarking - Reasons to benchmark, benchmarking process. Six sigma, 5S, Quality circles and Poka-Yoke.

TQM TOOLS **6**

Quality Function Deployment (QFD) - The voice of the customer, house of quality building house of quality and benefits of QFD. Failure Mode Effect Analysis (FMEA) - Reliability, Failure rate and Product Life Cycle, Stages of FMEA, Design and Process of FMEA document. Total Productive Maintenance (TPM).

QUALITY MANAGEMENT SYSTEM **3**

Features of ISO 9001:2015-Quality Management System and ISO 14001: 2015-Environmental Management System

Total Periods: 30

TEXT BOOKS

1. Dale.H.Besterfiled, et al., "Total Quality Management", Pearson Education Asia, 4th Edition, 2015.
2. Subburaj Ramasamy., "Total Quality Management", Tata McGraw Hill, New Delhi, 2012.

REFERENCES

1. James.R.Evans, & William.M.Lidsay., "Management and Control of Quality", Thompson Learning, 2005.
2. Narayana.V and Sreenivasan.N.S., "Quality Management - Concepts and Tasks", New Age Publications International Edition, 1996
3. Kanishka Bedi., "Total Quality Management", Oxford University Press, 2006.
4. Mukherjee.P.N, "Total Quality Management", Prentice Hall, 2005.

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME225 ECONOMICS FOR ENGINEERS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Illustrate the elements ofmacro and micro economics	PO1, PO2, PO11, PO12
CO2	Describe the use of cash flow diagrams for economic analysis	PO1, PO2, PO4, PO11, PO12
CO3	Outline the application of various depreciation calculation techniques for determining economic life of assets.	PO1, PO2, PO4, PO11, PO12
CO4	Summarize the applications of cash flow diagrams, depreciation methods for replacement and maintenance analysis	PO1, PO2, PO4, PO11, PO12
CO5	Apply replacement analysis to find out the best possible replacement time	PO1, PO2, PO4, PO11, PO12

INTRODUCTION TO ECONOMICS AND MACRO-ECONOMIC THEORIES 15

Introduction to Economics - Macro and Micro Economics- Law of supply and demand, Concept of Engineering Economics - Engineering efficiency, Economic efficiency, Scope of engineering economics. Make or buy decision, Value engineering : Function, aims, Value engineering procedure. Macro-Economic Theories:Poverty-meaning, absolute & relative poverty, causes, measures to reduce Unemployment: meaning, types, causes, remedies, Inflation: meaning, types, causes, measures to control

COST ANALYSIS, INTEREST FORMULAE AND CASH FLOW 15

Elements of cost: Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - Elementary economic Analysis :Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate. Methods of comparison of alternatives - Present worth method , Future worth method , Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method.

REPLACEMENT ANALYSIS AND DEPRECIATION 15

Replacement and Maintenance analysis - Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset - Capital recovery with return and concept of challenger and defender, simple probabilistic model for items which fail completely.

Depreciation :Introduction, Straight line method of depreciation, declining balance method of depreciation - Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation

Total Periods: 45

TEXT BOOKS

1. Panneer Selvam, R, Engineering Economics, Prentice Hall of India Ltd, New Delhi, 2001.
2. Donald.G. Newman, Jerome.P.Lavelle, Engineering Economics and Analysis Engg. Press, Texas, 2002

REFERENCES

1. Degarmo E.P., Sullivan W.G and Canada J.R, "Engineering Economy", Macmillan, 1984.
2. Grant E.L., Ireson W.G. and Leavenworth R.S, "Principles of Engineering Economy", Ronald Press, 1976.
3. Smith G.W., "Engineering Economy", Lowa State Press, Iowa, 1973.

WEB REFERENCE

1. https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-me35/

20EI219 LEADERSHIP EXCELLENCE AND DEVELOPMENT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Illustrate about positive outlook and critical thinking	PO9, PO10, PO11,PO12
CO2	Build the team work and leadership skills	PO9, PO10, PO11,PO12
CO3	Develop the communication and personality skills	PO9, PO10, PO11,PO12
CO4	Recognize the networking and interpersonal skills	PO9, PO10, PO11,PO12
CO5	Interpret the entrepreneurialleadershiprequirements	PO9, PO10, PO11,PO12

GROWTH MINDSET AND CREATIVE EYE **2**

DevelopingHabit - OvercomingSelf-LimitingBeliefSystem - Being&DoingPositive - Branding - ThinkoutofBox - Critical Thinking

LEADERSHIP **2**

BasicsofLeadership - TypeofLeadership - RoadAhead-Dream&Destination - CaseStudy

TEAM BUILDING **2**

BasicsofTeam - BuildingaGoodTeam - SuccessrecipeforGoodTeam - GroupTeamDiscussion

INTRAPERSONAL COMMUNICATION **2**

ChangingNegativeSelf-TalktoPositive - ManagingOverthinking

EMOTIONAL INTELLIGENCE & PERSONALITY DEVELOPMENT **2**

KnowYourself - ControlYourself - EmpowerYourself - TimeManagement - DressingforSuccess

NETWORKING & PEOPLE SKILLS **2**

InterpersonalSkills - Assertiveness - NegotiationSkills - ProblemSolving - DecisionMaking - Persuasiveness

ENTREPRENEURIAL SKILLS **5**

Frameworkfor entrepreneurialleadershiprequirements -
PersonalizedAssessmentofentrepreneurialorientation -
ExploretopcompetenciesandBehaviorsofsuccessfulEntrepreneurialleaders -
GaininsightintowhatdistinguishesEntrepreneurialLeadersfromTraditionalleaders -
EvaluatethegapsthatexistbetweenSelf-PerceptionversusActualResults -
LookatLeadershipCharacteristicsthatcontributetobeinganeffectiveleader -
ExamineFourKeySuccessFactorsandAttributesthatEntrepreneurialleadersexhibit -
HighlighttopInfluencesthatdriveEntrepreneurialleaderstotake-action -
EngageinadiscussionabouttheChallengesandOpportunitiesleadersface -
AskparticipantstoIdentifyGapsandareasneedingfurtherdevelopment -
PutinplaceIndividualActionPlansforeachparticipantmovingforward -
AssesstheEntrepreneurialOrientationattheteam,groupororganizationlevel -
IncludeExercisesandStoriesofsuccessfulEntrepreneurialleaders

Total Hours: 17

20IT218 WOMEN DEVELOPMENT AND EMPOWERMENT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Learn about diverse approaches to Gender Development.	PO8, PO12
CO2:	Sensitize about gender parity and women empowerment.	PO8, PO12
CO3:	Impart knowledge on Gender issues and laws.	PO8, PO12

WOMEN'S EMPOWERMENT AND GENDER PARITY **7**

Women and Gender Equality- Gender Sensitization- Status of women in Vedic Era- The Role of the United Nations in Universal Women's Empowerment- The Gender Role in Sustainable development (Feminism & Power)- Women and Leadership- Empowerment through Women's Education- Role of Women Entrepreneurs in India

GENDER INCLUSIVE APPROACHES AND LAW **8**

Different Approaches to Development - Women in Development (WID) - Women and Development (WAD) - Gender and Development (GAD) - Millennium Development Goals in India - Contemporary Gender and Health Issues- Personal laws for women - Criminal Laws for women - Right to self-defence.

Total Hours: 15

TEXT BOOKS

1. Adv. SanjivNarang, "Laws for Women in India", 2021.
2. Dr.ShikhaBhatnagar, "Women's Empowerment & Gender Equity", Notionpress, 2020.
3. Dr.AnujaMahapatra and Prof.SukhadebNaik, "Crime against Girls and Women: Global Perspective and Challenges", New Delhi, Enkay Publishing House, 2013.
4. Ed,Wendy Harcourt, "The Palgrave handbook on Gender and development", Palgrave Macmillan, 2016.
5. TambeAngha, "Development Gender Perspective", KrantijotiSavitribaiPhule Publication, Women's Studies Centre, SavitribaiPhule Pune University, Pune, 2010.

REFERENCES

1. Nirmala Banerjee, SamitaSen and NanditaDhawan, "Mapping the Field: Gender Relations in Contemporary India", Kolkata: School of Women's Studies, Jadavpur University, 2012.
2. Veltmeyer Henry (ed.), "The Critical Development Studies Handbook: Tools for Change", Fernwood Publishing, 2011.
3. Boserup, Ester, "Woman's Role in Economic Development", London, 2010.
4. Dr.AnujaMahapatra and Prof.SukhadebNaik, "Crime against Girls and Women: Global Perspective and Challenges", New Delhi, Enkay Publishing House, 2013.

20RA212 WORK SYSTEM ENGINEERING AND ETHICS 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Demonstrate the understanding of work system design by work study techniques	PO1, PO6, PO7
CO2:	Distinguish the manual and computer process planning methods used in modelling	PO1, PO6, PO7
CO3:	Summarize the concepts of production planning and control for industrial automation	PO1, PO6, PO7
CO4:	Explain the concepts of industrial ergonomics in man-machine automation	PO1, PO6, PO7
CO5:	Recognize concepts of ethics and moral values in engineering industries	PO1, PO6, PO7

WOMEN'S EMPOWERMENT AND GENDER PARITY **7**

Women and Gender Equality- Gender Sensitization- Status of women in Vedic Era- The Role of the United Nations in Universal Women's Empowerment- The Gender Role in Sustainable development (Feminism & Power)- Women and Leadership- Empowerment through Women's Education- Role of Women Entrepreneurs in India

GENDER INCLUSIVE APPROACHES AND LAW **8**

Different Approaches to Development - Women in Development (WID) - Women and Development (WAD) - Gender and Development (GAD) - Millennium Development Goals in India - Contemporary Gender and Health Issues- Personal laws for women - Criminal Laws for women - Right to self-defence.

Total Hours: 15

WORK SYSTEM DESIGN **15**

Productivity - Definition - reasons for low productivity - methods to improve productivity

Work Study: Basic Concept - Steps Involved in Work Study - Concept of Work Content - Techniques of Work Study - Human Aspects of Work Study.

Method Study: Objectives - basic procedure - Various recording techniques: Process charts - multiple activity charts - SIMO chart - flow diagram - string diagram - Principles of motion economy

Work Measurement: Purpose - basic procedure - various techniques of work measurement - Stop watch - time study

PROCESS AND PRODUCTION PLANNING **15**

Process Planning: Definition - Objective - Scope - Approaches to process planning - Manual Process Planning - Computer Aided Process Planning (CAPP) - Retrieval and Generative Model.

Production Planning and Control: Functions of production planning and control - Types of production systems - Routing - Loading and scheduling - Different methods of scheduling - Expediting - Dispatching

Ergonomics: Basic Concept - Industrial Ergonomics - Ergonomics: Anthropometry - Man-Machine System-1 - Man-Machine System-2 - Case Study of Assembly Line Worker

ENGINEERING ETHICS **15**

Definition of ethics - Morals values and ethics - integrity-Work ethics - Variety of moral issues - Moral dilemmas - Moral Autonomy - Theories about right action - Self-interest

Engineering as Experimentation - Engineers as responsible Experimenters - Codes of Ethics - Safety and Risk - Assessment of Safety and Risk - Risk Benefit Analysis and Reducing Risk - Respect for Authority - Conflicts of Interest - Occupational Crime - Professional Rights - Employee Rights - Intellectual Property Rights (IPR) - Discrimination

Multinational Corporations - Environmental Ethics - Computer Ethics - Engineers as Managers - Consulting Engineers - Engineers as Expert Witnesses and Advisors - Moral Leadership - Code of Conduct - Corporate Social Responsibility

Total Hours: 45

TEXT BOOKS

1. Panneerselvam.R, "Production and Operations Management", Prentice Hall of India Pvt. Ltd, 3rd Edition, 2012.
2. Mike Martin and Roland Scherzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.

REFERENCES

1. Khan.M.I, "Industrial Engineering", New Age International Publishers, 1st Edition, 2004.
2. Philip.E.Hicks, "Industrial Engineering And Management: A New Perspective", McGraw-Hill, 3rd Edition, 2007.
3. Govindrajan.M, Natarajan.S, SenthilKumar.V.S, "Engineering Ethics", Prentice Hall of India,Newdelhi,2004.
4. Charles D.Fledermann, "Engineering Ethics", Pearson Education / Prentice hall, New jersey,2000

WEB REFERENCES

1. http://nptel.ac.in/courses/112107143/
2. http://nptel.ac.in/courses/112107142/
3. http://nptel.ac.in/courses/112105126/26

20RA217 ECONOMICS FOR ROBOTICS AND AUTOMATION 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Describe the basics of economics, law of demand and supply.	PO1, PO7
CO2:	Perform and evaluate capital investment alternatives and cost analysis in manufacturing	PO1, PO7
CO3:	Perform the economics analysis of robot and cost consideration in automation	PO1, PO7
CO4:	Summarize the implementation phase and selection of tools in robotics and automation	PO1, PO7

ECONOMIC ANALYSIS- METHODS **9**

Law of supply and demand - Concept of Engineering Economics - Engineering efficiency -Some economic concepts - Value and utility - Interest and Interest rate - Time value of money - Interest formulas: Simple and compound interest - Cash flow diagrams - Replacement and Maintenance Analysis - Depreciation

PRODUCTION ECONOMICS AND COST ANALYSIS **12**

Production economics - Elements of economic analysis - sensitivity analysis - Methods of Evaluating Capital Investment Alternatives - Costs in Manufacturing - Elements of Cost - Break-Even Analysis -Make or buy decision - Unit cost of production - Cost of Manufacturing - Lead time and Work-in-process - Different costing methods - product life cycle cost analysis - Tools and techniques

ECONOMIC ANALYSIS OF ROBOTS AND AUTOMATION **15**

Type of robot installation - cost data required for the analysis - Methods of Economic analysis - Payback - ROI - EUAC - Cash flow method - problems - subsequent uses of robot - Difference in production rates - other factors - Robot project analysis form.

Cost considerations in Industrial Automation - Procurement and deployment - Operations and maintenance - End-of-Life (EOL) management - Monte carlo method

IMPLEMENTING ROBOTICS AND AUTOMATION **9**

Familiarization with robotics and automation technology - plant survey to identify potential applications - Selection of the best applications - Selection of a robot and automation tools - detailed economic analysis - planning and installation

Total Hours: 45

TEXT BOOKS

1. Mikell P. Groover, Mitchell weiss, Roger N. Nagel, Nicholas G.Odrey, Ashis Dutta, "Industrial Robotics 2e-Technology, Programming and Applications ", McGraw Hill, 2012
2. PanneerSelvam, R, "Engineering Economics", Prentice Hall of India Ltd, 2001.

REFERENCES

1. Riggs.J.L, Engineering Economy, 4th edition, McGraw Hill, 2002
2. Richard D. Klafter, Thomas. A, Chrielewski, Michael Negin, "Robotics Engineering an Integrated Approach", Prentice Hall of India Pvt. Ltd., 1989
3. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and Analysis", Engg. Press, Texas, 2002.
4. Degarmo E.P., Sullivan W.G and Canada J.R, "Engineering Economy", Macmillan, 1984

WEB REFERENCES

1. https://nptel.ac.in/courses/112/107/112107209/#

ENLIGHTENMENT THROUGH EDUCATION
SREC

BASIC SCIENCES (BS)

ENLIGHTENMENT THROUGH EDUCATION
SREC

20AEI01 **DESIGN THINKING** **1 0 0 1**

COURSE OUTCOMES

On completing this course the student will be able to,

CO1:	Understand the importance of Design Thinking	PO1, PO2, PO3
CO2:	Evaluate the quality information and emotions & keep thinking straight.	PO2, PO3, PO4
CO3:	Identify skills and personality traits of successful problem solving	PO2, PO3, PO4
CO4:	Apply standard problem-solving heuristics to aid in problem solving	PO2, PO3, PO4
CO5:	Apply problem-solving techniques to programming activities.	PO1, PO5
CO6:	Formulate and successfully communicate the solutions to problems	PO3, PO10

INTRODUCTION TO DESIGN THINKING **2**

Definition of Design Thinking, Business uses of Design Thinking , Variety within the Design Thinking Discipline, Design Thinking Mindset

EMPATHIZE PHASE **2**

Customer Journey Mapping: Fundamental Concepts, Empathy, Ethnography, Divergent Thinking, Convergent Thinking, Visual Thinking, Assumption Testing, Prototyping, Time for Learning and Validation.

Design Thinking Resources: People, Place, Materials, Organizational Fit

Design Thinking Processes: Numerous Approaches

ANALYZE PHASE **5**

5-Whys and How:

Process Stages of Designing for Growth, What Is, What If , What Wows, What Works, Design Thinking Tools and Methods, Purposeful Use of Tools and Alignment with Process, What Is: Visualization, What Is: Journey Mapping, What Is: Value Chain Analysis, What Is: Mind Mapping, What If: Brainstorming, What If: Concept Development, What Wows: Assumption Testing, What Wows: Rapid Prototyping, What Works: Customer Co-Creation, What Works: Learning Launch, Design Thinking Application, Design Thinking Applied to Product Development

SOLVE PHASE **2**

Ideation: Free Brainstorming.It's time to experiment! Through trial and error, team identifies which of the possible solutions can best solve the identified problem(s).

MAKE/TEST PHASE **4**

Prototype: Testing is essential because everything, ultimately, should be about the people who will use your products. Time to revisit the problem statement and make sure the end solution is meeting those needs and resolving frustrations.

TEXTBOOKS

1. Design Your Thinking (English, Hardcover, Soni Pavan)

2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, by Eric Ries

REFERENCES

1. https://ryanstutorials.net/problem-solving-skills/
2. https://www.interaction-design.org/literature/topics/design-thinking
3. https://www.designbetter.co/design-thinking
4. https://www.invisionapp.com/inside-design/what-is-design-thinking/

CASE STUDIES

1. https://theaccidentaldesignthinker.com/2017/09/16/40-design-thinking-success-stories/
2. https://voltagecontrol.com/blog/8-great-design-thinking-examples/
3. http://www.talenteducation.eu/toolkitforteachers/designthinking/projects/

LIST OF EXERCISES

1. Project planning - Introduction to teamwork & how to make collaboration work
2. Five whys" or "Nine Whys" exercise
3. The "Six Thinking Hats" exercise

ENLIGHTENMENT THROUGH EDUCATION SREC

COURSE OUTCOMES

On completing this course the student will be able to,

CO1	Use variables, expression, function definition to solve linear and non-linear equations and matrix manipulation	PO1
CO2:	Analyse ODE and plot graphs by importing data into workspace	PO2
CO3:	Create a subsystem using various blocks in a Block set	PO3
CO4:	Use m Files in various environments and interfacing external hardware	PO5
CO5:	Communicate the results of the experiments through reports	PO9, PO10, PO12

List of Experiments

1. Implementation of Fibonacci Series.
2. Solving linear and non linear equations
3. Interpolation and Curve fitting
4. Data Visualization using GraphicalUtilities
5. Solving Ordinary Differential Equations and plotting thefunction
6. Creating standalone Applications.
7. Creating subsystems for simpleapplications
8. Access of mfiles
9. Creating a function using mfile
10. Interfacing withhardware.

REFERENCES

1. Brian R. Hunt, Ronald L. Lipsman and Jonathan M. Rosenberg, "A Guide to Matlab for beginners and experienced users", Cambridge University Press,2001.
2. Stormy Attway, "Matlab: A Practical Introduction to programming and problem solving", 4th edition, Butterworth-Heinemann, 2017.
3. S.R. Otto and J.P. Denier, "An Introduction to Programming and Numerical Methods in MATLAB", Springer,2005.

20BM201 **BIOCHEMISTRY** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Explain the structure and functions of subcellular organelles and biomolecules	PO1
CO2:	Describe metabolism of liver, muscle, heart and brain.	PO1
CO3:	Describe the procedures for assessment of functions of liver and kidney.	PO1
CO4:	Explain the principles of biochemical techniques.	PO1

BIOMOLECULES **15**

Biochemistry of living cell- Structural features of eukaryotic and prokaryotic cells- Functions of cell organelles - Sub cellular fractionation using differential centrifugation. Classification, structure and functions of carbohydrates, lipids, proteins and nucleic acids. Enzymes - Classification, kinetics, Inhibition, Assay of enzymes. Diagnostic enzymes. Hormones- Chemical nature, General mode of action. Assay of hormones.

METABOLISM **15**

Metabolism in major organs- liver, muscle, heart and brain and their regulation. Major inherited metabolic disorders of carbohydrate, lipid and protein metabolism. Metabolic Integration in conditions like Diabetes, starvation. Regulation of gene expression in eukaryotes.

CLINICAL BIOCHEMISTRY **15**

Principles and applications of chromatography, electrophoresis, spectroscopic techniques. Organ analysis: Assessment of kidney and liver functions. Blood gas Analysis. Regulation of acid-base balance. Measurement of electrolytes. Uses of radioisotopes in biology and medicine.

Total Hours: 45

TEXT BOOKS

1. Michael M. Cox and David L. Nelson, "Lehninger Principles of Biochemistry", W. H. Freeman and Company, 7th Edition, New York, 2017.
2. Keith Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology, 8th Edition, Cambridge University Press,2018.

REFERENCES

1. Reginald H. Garrett and Charles M. Grisham, "Biochemistry", Brooks Cole Publishers, 6th Edition, California, 2017.
2. Robert K. Murray and Victor W. Rodwell, "Harper's Illustrated Biochemistry, Lange Medical Books, 31st Edition, 2018.
3. Donald Voet, Judith G. Voet and Charlotte W. Pratt, "Fundamentals of Biochemistry", JohnWiley & Sons,5th edition, New Jersey, 2014.

20BM203 HUMAN ANATOMY AND PHYSIOLOGY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the body planes and organization of tissues	PO1
CO2:	Explain the components and functions of cardiovascular, nervous, respiratory, digestive, excretory and Sensory system	PO1

INTRODUCTION **5**

Origin of anatomical names - Prefixes and suffixes -Anatomical positions and body planes. Types and organization of tissues. Functional organization and homeostatic mechanisms of the major functional systems. Control systems of the body.

NERVOUS AND SENSORY SYSTEM **10**

Membrane potentials and action potentials- contraction and excitation of muscle. Organization and functions of the nervous system. Nerve conduction and synapse. Reflex action- Somatic and autonomic nervous system. Motor functions and control. Special senses -optics and physiology of vision, senses of hearing, taste and smell. Cerebral blood flow. Cerebrospinal fluid system.

CARDIOVASCULAR SYSTEM **8**

Composition of blood -hemostasis and blood coagulation. Structure of circulatory system - Heart -Cardiac cycle-Normal Electrocardiogram. Blood pressure and its regulation. Nervous regulation of circulation. Cardiac output, venous output and their regulation. Coronary, pulmonary and peripheral circulation.

RESPIRATORY SYSTEM **7**

Structure of respiratory system. Physiological aspects of respiration. Exchange of gases through respiratory membrane. Transport of gases in blood and tissue fluids. Regulation of respiration. Lung volume and vital capacities of the lungs.

DIGESTIVE AND EXCRETORY SYSTEM **15**

Organization and functions of GI system. Physiologic anatomy of liver. Secretions, digestion and absorption in the GI tract. Body fluids and Kidneys. Mechanism of urine formation. Renal mechanisms for control of blood and extracellular fluid volume. Role of kidneys in regulation of blood pressure. Regulation of acid-base balance.

Total Hours: 45

TEXT BOOKS

1. John E Hall, Guyton and Hall, "Text book of Medical Physiology", 14th Edition, Elsevier, 2020.
2. Anne Waugh and Allison Grant, Ross and Wilson "Anatomy and Physiology in health and illness", 12th Edition, Churchill Livingstone Elsevier, 2014.
3. William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill,2010.

REFERENCES

1. Elaine.N. Marieb, "Essentials of Human Anatomy and Physiology", 8th Edition, Pearson Education, 2007.
2. Gillian Pocock, Christopher D. Richards, "The Human Body - An Introduction for Biomedical and Health Sciences", Oxford University Press, 2009.

Course Outcomes:

On successful completion of the course, the students will be able to

CO1:	Comprehend the key building blocks and processes of life at all levels of biological organization.	PO1
CO2:	Recognize engineering problems and find potential biological solutions by biomimicry approach.	PO1

TREE OF LIFE **10**

Darwinian evolution & molecular perspective; Introduction to phylogeny - Classification systems in biology and relationships; Cellular assemblies - From single cell to multi-cellular organisms: Geometry, Structure and Energetics.

MOLECULAR PROCESSES **10**

Gene regulation, protein synthesis, energy metabolism, sensing at the cell level, rotary motors at the Nano scale, cellular decision making networks, photosynthesis, embryonic development, cell-cell communication, physiology, self-organization, self- repair, evolution, ecosystem dynamics, geochemical ecological cycles, ecosystem resilience.

BIOLOGICALLY-INSPIRED INNOVATION IN ENGINEERING DESIGN **10**

Introduction to Biomimicry, Design Process- Problem driven BID process- Solution Driven BID process-Tools; Application of Biomimetics in artificial intelligence, bioinformatics and computational biology, robotics, smart materials, medical devices, biosensors, architecture and human computer interfaces.

Total Hours: 30

TEXT BOOKS

1. Scott Freeman, "Biological Science", 2017. Pearson Education Limited.
2. Miko, I. &Lejeune, L.,eds. "Essentials of Genetics, 2009". Cambridge, MA: NPG Education.
3. Yoseph Bar-Cohen, "Biomimetics: Nature-Based Innovation", 2012. CRC Press.

REFERENCES

1. Dawkins, R. "The Greatest Show on Earth: The Evidence for Evolution", Bantam Press, Trans world Publishers, Random House Group, London, 2009.
2. Janine M. Benyus, "Biomimicry-Innovation inspired by Nature", 2002, Harper Collins.

20BM206 BIOLOGY FOR ENGINEERS 1 0 0 1

Course outcomes

On successful completion of the course, the students will be able to

CO1:	Explain the biological materials and surfaces, basic mechanisms in biology	PO1
CO2:	Explain biological materials and processes as a source of engineering design	PO1

PREREQUISITE: Nil

Nature as an inspiration for Human Innovation **8**

Tree of life and Molecular processes. Mimicking and Inspiration of nature for engineering design. Nature as a model for structures, parts and tools, mechanisms. Defense and attack mechanisms in biology. Biological materials, processes - examples of inspirational materials, multifunctional materials and intelligent characteristics. Biologically inspired control.

Bio-inspired Design Process **7**

Biomimetic processes for engineering design. Bio inspired sensors in engineering applications. Robotics emulating biology. Aerodynamic and hydrodynamic mobility, social and other biological behaviors, interfacing biology and machines- Bionics.

Total Hours: 15

TEXT BOOKS

1. Scott Freeman, "Biological Science", 2017. Pearson Education Limited.
2. Yoseph Bar-Cohen, "Biomimetics: Nature-Based Innovation", 2012. CRC Press.

REFERENCES

1. Helena HashemiFarzaneh&UdoLindemann. "A Practical Guide to Bio-inspired Design". 2019. Springer Nature.
2. S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.
3. Janine M. Benyus, "Biomimicry-Innovation inspired by Nature", 2002, Harper Collins.

20BM217 CONCEPTS OF MEDICAL DEVICE DESIGN 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Explain the biomedical engineering design in the industrial context.	PO1
CO2:	Specify the hardware development methods and tools for medical device design.	PO5
CO3:	Specify the software development methods and tools for medical device design	PO5
CO3:	List the human and biological factors to be considered in medical device design.	PO3

DESIGN OF BIOMEDICAL DEVICES AND SYSTEMS **6**

The essentials of design, Biomedical engineering design in industrial context, industrial design process, Fundamentals design tools, Brain storming and idea generation techniques, Elementary decision- making techniques, objectives trees, quality function deployment diagrams- process, requirements, design, verification and validation, Design team management, reporting and documentation.

HARDWARE DEVELOPMENT METHODS AND TOOLS **6**

Design for six sigma, Methodologies, Structure, Design for six sigma tools, Component Derating, Safety margin, Load protection, Environmental protection, Product misuse, Reliability prediction, Design for variation, Design of experiments, Design changes, Design for manufacturability, Design for assembly, Design reviews.

SOFTWARE DEVELOPMENT METHODS AND TOOLS **6**

Software design levels, Design alternatives and trade-offs, Software architecture, Choosing a methodology, Structure analysis, Object oriented design, Choosing a language, Soft ware risk analysis, The requirements trace ability matrix, Software review, Performance predictability. Module specifications, Coding, Design support tools.

HUMAN FACTORS **6**

The human element in human factors engineering, The hardware element and the software elements in human factors, The human factors process. Industrial design and considerations. Analysis of test data, The definition of reliability, Types of reliability, Failure rate, Mean time between failures, Reliability, Confidence level and limits.

BIOLOGICAL ENGINEERING DESIGNS **6**

Biomedical System, Special issues when dealing with non human subjects, Unintended consequences, Environmental interactions, Biological principles, Design objectives, Resistance development, regulations and standards, Ethics, Biological engineering design examples

Total Periods: 30

TEXT BOOKS

1. Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical devices and systems", 3rd Edition, CRC Press, 2016.
2. Mathew Bret Weinger, Michael E Wiklund, Daryle Jean Gardner- Bonneau. "Hand Book of Human factors in Medical Device Design", CRC Press 2010

REFERENCES

1. Peter J. Ogrodnik, "Medical Device Design: Innovation from Concept to Market", Academic Press, 2012.
2. "Biodesign: The Process of Innovating Medical Technologies", Paul Yock, Stefanos A. Zenios, and Todd J. Brinton, Cambridge University Press, 2015.
3. Peter J. Ogrodnik Class 1 Devices: "Case Studies in Medical Devices Design", Academic Press, 2014

20BM270 BIOCHEMISTRY LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify the biomolecules present in a given sample by qualitative analysis.	PO1
CO2:	Determine the concentration of biomolecules in the biological samples.	PO1
CO3:	Measure the activities of enzymes and their properties.	PO1

EXPERIMENTS

Preparation of Buffer and measurement of pH, qualitative and quantitative analysis of carbohydrates, lipids, proteins and nucleic acids. Thin Layer Chromatography of lipids. Chromatography of protein hydrolysates - Enzyme kinetics - assay of enzyme activity, study of effect of substrate and enzyme concentration, effect of pH, temperature and inhibitors.

REFERENCE

1. Sivan and Naik, Manipal Manual of Clinical Biochemistry, 4th edition, Elsevier India, 2014.

ENLIGHTENMENT THROUGH EDUCATION SREC

20BM271 HUMAN ANATOMY AND PHYSIOLOGY LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify parts of cardiovascular and skeletal system	PO1
CO2:	Study the blood parameters to understand hematological variations.	PO1
CO3:	Measure blood pressure, respiration rate and acquire ECG.	PO1
CO4:	Perform tests to assess vision and hearing.	PO1

EXPERIMENTS

Identification of functional parts of the cardiovascular and skeletal systems. Blood groups, Blood cell counts and Hemoglobin. Measurement of blood pressure. Measurement of respiration parameters.Acquisition of biosignals-ECG. Testing of vision and color blindness. Testing of hearing and recording of audiogram.

REFERENCE

1. Charles Henry Stowell, "A Handbook of Simple Experiments in Physiology", Burdett & Co, 2006.

ENLIGHTENMENT THROUGH EDUCATION SREC

20BS201 **PHYSICAL SCIENCES** **4 0 0 4**

PHYSICS

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Summarize the properties of semiconductors and magnetic materials.	PO1
CO2:	Illustrate the working of various light emitting devices, optical fibers and photo detectors with their applications.	PO1
CO3:	Apply the principles of laser to various optical devices used for memory storage.	PO1, PO5

SEMICONDUCTING MATERIALS **4**

Elemental and compound semiconductors - Intrinsic and extrinsic semiconductors -Properties

MAGNETIC MATERIALS **6**

Definition of fundamental terms - Material - Classification - Dia, Para, Ferro and ferri magnetic materials - Properties - Heisenberg and Domain theory of ferromagnetism - Hysteresis - Hard and soft magnetic materials - Ferrites - structure, preparation and applications

PHOTONICS **6**

Lasers: Applications - Computer peripherals - Fiber Optics: Applications - Fiber optical communication - Fiber optic sensors - Electromagnetic radiation Polarization - Production and Detection of Plane, Circular and elliptically polarised light

SOURCES AND DETECTORS **6**

Light Emitting Diode - Organic LED's - Polymer light emitting materials - Plasma light emitting devices - LCD's - Semiconductor Diode - PIN and Avalanche Photodetector.

MAGNETIC AND OPTICAL STORAGE TECHNIQUES **8**

Magnetic Memories - Optical Data Storage - Phase Change Recording - Magneto - Optical Data Storage - Hi-Tech involved in System Development - Capacity of Storing Devices - Holographic Storage - Construction and Reconstruction of a Hologram - Photorefractive Storage - Bubble memory - DVD - Blue-ray disc - Flash memory.

Total Hours : 30

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.
2. Avadhanalu M N, and Kshirsagar P G, "A Textbook of Engineering Physics", S. Chand & Company Ltd, 2018.

REFERENCES

1. Charles Kittel, "Solid State Physics", John Wiley and Sons, 8th Edition, 2012.
2. Raghavan V, "Materials Science and Engineering - A first Course", PHI Private limited, 6th Edition, 2015.

WEB REFERENCES

1. https://nptel.ac.in/courses/104104085/
2. http://nptel.ac.in/courses/122107035/
3. http://nptel.ac.in/courses/112104026/
4. http://nptel.ac.in/courses/115107095/
5. https://nptel.ac.in/courses/113105025/
6. https://nptel.ac.in/content/storage2/courses/113104005/lecture_pdf/module6.pdf

CHEMISTRY

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply the principles of electrochemistry to various electrochemical devices.	PO1
CO2:	Summarize the synthesis and properties of polymers and nano materials.	PO1
CO3:	Make use of the characteristic properties of materials for engineering applications.	PO1

ELECTROCHEMISTRY AND ENERGY STORAGE DEVICES **15**

Electrochemistry: Electrochemical cells -Electrode potential - Emf measurement -Nernst equation - Weston cadmium cell - Electrochemical series - Significance-Polarization, Decomposition potential, Over voltage - Types of electrodes: Calomel electrode and Glass electrode - Ion selective electrodes.

Batteries:Types - Primary batteries, Secondary batteries-Modern batteries - Zinc air and Lithium-ion battery - Speciality batteries: Nickel hydride battery, Torpedo battery - Battery recycling -Super capacitors -Fuel Cells: Proton exchange membranefuel cell - Direct methanol - O2 fuel cell.

MATERIALS CHEMISTRY **15**

Polymers-Polymerization- Structure, properties and uses of industrially important polymers - PVC - Teflon - ABS - Speciality polymers: Polycarbonate, Kevlar -Electronic polymers: Polyacetylene, Polyaniline, Polythiophene- Polymer blends and alloys - Photo and electroluminescence materials.

Nanochemistry: Nanomaterials- Chemical Synthesis -Nucleation - Mechanism of homogeneous and heterogeneous nucleation-Hydrothermal and Sol-gel methods- Properties and applications of nanomaterials - Nanotubes of metals - ZnO, Fe2O3 nanotubes - Synthesis, special features and applications- Carbon fibres - Properties and applications- Graphenes - Applications.

Total Hours: 30

TEXT BOOKS

1. Jain P C and Monica Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai publishing Co., 2016.
2. Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science", 3rd Edition, New Age International (P) Ltd., New Delhi, 2019.

REFERENCES

1. Dara S S., "A text book of Engineering Chemistry", 12th Edition, S.Chand & Co. Ltd., 2013.
2. Shashi Chawla "A Textbook of Engineering chemistry", 3rd Edition, Dhanpat Rai Publications, 2010.
3. Cao G., "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", 2nd Edition, ICP, London, 2004.

WEB REFERENCES

1. http://nptel.ac.in/courses/122101001/downloads/lec-23.pdf
2. http://nptel.ac.in/courses/104105039
3. www.fi.tartu.ee/rynno/raamat/Introduction%20nanomaterials-sisu.pdf

20BS270 **BASIC SCIENCES LABORATORY** **0 0 2 1**

A. PHYSICS LABORATORY

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Experiment with laser to find its wavelength and particle size of the given lycopodium powder.	POI, PO9
CO2:	Utilize the appropriate method to find the modulus of elasticity of the given material.	PO1, PO2, PO5 PO9, PO12
CO3:	Make use of optical fiber to obtain the Numerical Aperture and Acceptance angle.	PO1, PO2, PO5 PO9, PO12
CO4:	Analyse the characteristics and efficiency of the solar cell.	PO1, PO5, PO9
CO5:	Examine the thickness of a thin film using the principle of interference.	PO1, PO2, PO9
CO6:	Compare the wavelength of Mercury spectrum using diffraction grating.	PO1, PO5, PO9
CO7:	Find the band gap of the given Semiconductor diode by suitable experimental setup.	PO1, PO2 PO5, PO9
CO8:	Experiment with B-H curve to estimate the energy loss in a magnetic material.	PO1, PO2, PO9
CO9:	Make use of Ultrasonic waves to evaluate the acoustical parameters.	PO1, PO5, PO9
CO10:	Examine Dielectric Constant of the given material.	PO1, PO2, PO9
CO11:	Make use of XRD to determine the lattice parameters of crystalline materials and sputtering unit of the deposited thin film.	PO1, PO2, PO5
CO12:	Develop effective communication skills through reports.	PO1, PO10

LIST OF EXPERIMENTS

1. Determine the Wavelength of the semiconductor laser source.
2. Determine the size of the given powder particle by forming diffraction pattern.
3. Determination of Young's Modulus of the given material of the rectangular bar using Cantilever method.
4. Determination of Rigidity Modulus of the wire by using Torsional pendulum.
5. Estimation of Acceptance angle and Numerical Aperture (NA) of the Optical fiber.
6. Estimation of the efficiency of a solar cell and to study its characteristics.
7. Determination of thickness of a thin film - Air Wedge method
8. Determination of wavelength of Mercury spectrum using diffraction grating.
9. Determination of the band gap of the given Semiconductor diode.
10. Estimation of the Energy loss in a magnetic material - B-H curve
11. Determine the velocity of the Ultrasonic waves in the given liquid medium and to determine the acoustic impedance using ultrasonic interferometer.
12. Determination of the Dielectric Constant of the material.
13. Demonstration and determination of lattice parameters of crystalline materials using XRD.
14. Demonstration of thin film deposition technique using Sputtering Unit.

Note : Chairpersons of the concerned Board will choose the experiments

B - CHEMISTRY LABORATORY

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Examine various water quality parameters by suitable analysis methods.	PO1, PO7, PO9
CO2:	Apply EDTA method to determine the elements present in alloys quantitatively.	PO1, PO9
CO3:	Infer the strength of acid in the given sample using pH meter.	PO1, PO5, PO9
CO4:	Infer the strength of acids using electrical instruments.	PO1, PO5, PO9
CO5:	Make use of potentiometer to determine the amount of ferrous iron.	PO1, PO5, PO9
CO6:	Make use of electrical instruments to determine the amount of ferrous ion and concentration of nickel.	PO1, PO5, PO9
CO7:	Utilize the weight loss method to determine efficiency of corrosion inhibitors.	PO1, PO9
CO8:	Examine the thickness of the anodic film formed by anodization of aluminium.	PO1, PO9
CO9:	Illustrate the determination of molecular weight of polymers by viscometric method.	PO1, PO9
CO10:	Illustrate the method to determine reaction rate constant of a first order reaction.	PO1, PO9
CO11:	Analyze the physical properties of a fuel.	PO1, PO9
CO12:	Develop effective communication skills through reports.	PO10

LIST OF EXPERIMENTS

1. Estimation of hardness of water by EDTA method.
2. Estimation of calcium and magnesium independently by EDTA method.
3. Estimation of alkalinity of water.
4. Estimation of dissolved oxygen by Winkler's method.
5. Estimation of total chloride in water.
6. Estimation of Ni in steel/Cu in brass by EDTA method.
7. Determination of strength of given hydrochloric acid by pH metry.
8. Estimation of mixture of acids by conductometric method.
9. Estimation of ferrous iron by potentiometric method.
10. Estimation of Ni using DMG by spectrophotometric method.
11. Determination of efficiency of corrosion inhibitors.
12. Anodization of aluminium and determination of thickness of anodic film.
13. Determination of molecular weight of the polymer by Ostwald Viscometry.
14. Determination of reaction rate constant of a first order reaction.
15. Analysis of a fuel by proximate analysis method.

Note: Chairpersons of the concerned board will choose the experiments

20CE201 BASICS OF GEOLOGY 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Recall the role of geology in the design and construction process of civil engineering structures.	PO1, PO7
CO2:	Interpret the inherent behavior of various rocks and minerals according to plate tectonic theory.	PO1, PO7
CO3:	Calculate the properties of rocks based on physical and engineering behavior for its application in construction industries.	PO1, PO7
CO4:	Infer the geological conditions through geological cross section studies for safety and suitability of structures.	PO7

PHYSICAL GEOLOGY **4**

Role of Geology in Civil Engineering - Weathering and its types - Geological work of river, wind, sea and ground water

MINERALOGY **4**

Various crystallographic systems - Physical and Engineering properties of Minerals -Morphology- Quartz and Feldspar group - Kaolinite, Montmorillonite, Illite, Vermiculite, Chlorite Minerals - Elementary knowledge on Ore minerals.

PETROLOGY **3**

Classification of rocks - Igneous - Sedimentary and Metamorphic rocks. Description, occurrence, engineering properties, distribution and uses of Granite, Dolerite, Basalt, Sandstone, Limestone, Laterite, Shale, Quartzite, Marble, Slate, Gneiss and Schist

STRUCTURAL GEOLOGY **4**

Geological maps and their importance in civil engineering projects -3D Earth- Uses of Clinometer and Brunton compass in Geological mapping - Classification of Folds and joints in Geology.

Total Hours: 15

TEXT BOOKS

1. Parbin Singh A., "Text Book of Engineering and General Geology", S.K.Kataria and Sons, 8th edition, New Delhi, 2015.
2. Garg S.K., "Physical and Engineering Geology", 3rd Edition, Khanna Publishers, New Delhi, 2015.

REFERENCES

1. Dugal S.K et. al., "Engineering Geology", McGraw Hill Education (India) (P) Ltd. 2014.
2. Blyth F.G.M., "A Geology for Engineers", 2nd Edition, Arnold, London, 2016.
3. Reddy D.V., "Engineering Geology", 2nd Edition, Vikas Publishing House Pvt Ltd., Noida, UP, 2017.

WEB REFERENCE

1. NPTEL Course on Engineering Geology http://nptel.ac.in/courses/105105106/

20CE202 PRINCIPLES OF ARCHITECTURE AND PLANNING CONCEPTS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Explain the principles and planning aspect of different types of building in architectural view.	PO1
CO2:	Summarize the development control for area and primary elements in architecture.	PO1
CO3:	Apply the architecture design concepts in civil engineering projects.	PO1, PO5, PO9

ARCHITECTURAL PRINCIPLES 7

Introduction to architecture - elements of architecture - primary forms - organizing principles - proportion, scale, balance, symmetry, hierarchy, axis with building examples from historical & contemporary architecture.

PLANNING ASPECTS & REGULATIONS 8

Building types & design criteria - Space standards for residential, commercial & institutional categories. Building bye laws applicable for approval by the local governing body - Development control rules for area

PRIMARY ELEMENTS IN ARCHITECTURE 7

Geometry in Architecture - points, lines and shapes.-Linear elements -planar elements and volumetric elements.-Patterns in nature and building design-Order to chaos.-Regularity and irregularity.

CONCEPTS IN ARCHITECTURAL DESIGN 8

Concept - types - Ideas and Intent in design - Intuitive, contextual, Iconic, Experiential, Symbolic and Modular. Ideologies and philosophies of architects. Case Studies. Importance of graphics in architectural design. Study of site plans, city plans, conceptual drawings. Interpretation of architects' conceptual sketches and the respective buildings

Total Hours: 30

TEXT BOOKS

1. Peter von Meiss, "Elements of architecture - from form to place", Spon Press 2013.
2. Vaidyanathan .G, Kulasekaran .I, Sathishkumar .G, "Building planning & construction companion", Edifice Institute of Building services publication, 2002.

REFERENCES

1. Jerry Yudelson, "Marketing Green Buildings: Guide for Engineering, Construction and Architecture", The Fairmont Press Inc., 2006.
2. M. Bauer, P. Mosle and M. Schwarz, "Green Building: Guidebook for Sustainable Architecture", Springer - Verlag Berlin Heidelberg, 2010.

WEB REFERENCE

1. https://nptel.ac.in/courses/124/105/124105001/

20CE208 **APPLIED GEOLOGY** **1 0 0 1**

COURSE OUTCOMES

On Successful completion of the course, students will be able to

CO1:	Recall the role of geology in the design and construction process of civil engineering structures.	PO1.PO6,PO7
CO2:	Interpret the inherent behavior of various rocks and minerals according to plate tectonic theory.	PO1.PO6,PO7
CO3:	Examine the properties of rocks based on physical and engineering behavior for its application in construction industries.	PO1.PO6,PO7
CO4:	Predict the geological conditions through geological cross section studies for safety and suitability of structures.	PO1, PO2, PO6,PO7

PHYSICAL GEOLOGY **4**

Role of Geology in Civil Engineering- Weathering and its types- Geological work of river, wind, sea and ground water.

MINERALOGY **4**

Various crystallographic systems - Physical and Engineering properties of Minerals -Morphology- Quartz and Feldspar group - Kaolinite, Montmorillonite, Illite, Vermiculite, Chlorite Minerals.

PETROLOGY **3**

Classification of rocks - Igneous - Sedimentary and Metamorphic rocks - Description, occurrence, engineering properties, distribution and uses of Granite, Dolerite, Basalt, Sandstone, Limestone, Laterite, Shale, Quartzite, Marble, Slate, Gneiss and Schist.

STRUCTURAL GEOLOGY **4**

Geological maps and their importance in civil engineering projects -3D Earth- Uses of Clinometer and Brunton compass in Geological mapping - Classification of Folds and joints in Geology.

Total Hours: 15

CASE STUDIES

1. Case Study on minerals impact in construction failure
2. Topographical Depiction from Google Earth

TEXT BOOKS

1. Parbin Singh A., "Text Book of Engineering and General Geology", 8th edition, S.K.Kataria and Sons, Eighth Edition, Delhi, 2015.
2. Garg S.K., "Physical and Engineering Geology", Third Edition, Khanna Publishers, Delhi, 2015.

REFERENCE BOOKS

1. Dugal S.K et. al., "Engineering Geology", McGraw Hill Education (India) (P) Ltd. 2014.
2. Blyth F.G.M., "A Geology for Engineers", 2nd Edition, Arnold, London, 2016.
3. Reddy D.V., "Engineering Geology", 2nd Edition, Vikas Publishing House Pvt Ltd., Noida, UP, 2017.

WEB REFERENCE

1. NPTEL Course on Engineering Geology http://nptel.ac.in/courses/105105106/

20CE218 LANDSCAPING AND INTERIOR DESIGN 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the basic concepts of landscape design for water and landforms.	PO1
CO2:	Infer the landforms and plants components for appropriate garden design.	PO1
CO3:	Examine the significance of urban landscape design and green infrastructure guidelines for efficient planning.	PO1, PO2
CO4:	Illustrate the spacing guidelines for interior design.	PO1, PO2
CO5:	Select the suitable colour for interior & exterior design using software.	PO2, PO5

LANDSCAPE AND ITS ELEMENTS **5**

Basic concepts of ecology- Reclamation and restoration of derelict lands. Hard and soft landscape elements, Plant materials, Water and Landform - classification, characteristics, use and application in landscape design.

GARDEN DESIGN **5**

Design with plants - Basic principles of designs- Physical attribute of plants and relation to design- Appearance, functional and visual effects of plants in landscape design and built environment. Plant Components - Annuals - Shrubs -Trees - Climbers -Indoor Plants - Ornamental Palms and Bulbous Plants.

URBAN LANDSCAPE DESIGN **6**

Urban open spaces and principle of urban landscape; Street landscaping, landscape design for waterfront areas and functional areas in urban centers. Green infrastructure including green roofs and walls. Application of Plant Physiography to sustainable landscape design such as use of CAM (Crassulacean Acid Metabolism) plants in Green roofs.

INTERIOR SPACE **6**

Space - definition; Interior space - Spatial qualities- form- scale- outlook-Guidelines for structuring space with interior design elements; spatial form; spatial dimension - square, rectangle-curvilinear spaces; height of space-spatial transitions - openings within wall planes- doorways- windows- stairways. Heat and sound insulation materials in interior Design.

PRINCIPLES OF AESTHETICS DESIGN **8**

Colour wheel - primary- Secondary- Tertiary Colours'- Colour schemes- Colour value- intensity and modification of Colourhues - Tints- shades- Neutralization. Colour charts - types- Colour harmony-use of Colour harmony- Ratio, proportion, scale, balance, harmony, unity, variety, rhythm, emphasis.

Total Hours: 30

CASE STUDIES

1. Application of Software in interior decoration for residential and commercial building.

TEXT BOOKS

1. Charles Harris, Nicholas Dines, "Time-Saver Standards for Landscape Architecture", McGraw Hill Education, 2nd edition, 2017.
2. Joseph Dechiara, Julius Panero and Martin Zelnik, "Time Saver Standards for Interior design andSpace Planning", McGraw Hill, London, 2011.

REFERENCE BOOKS

1. William S. Saunders. Nature, Landscape, and Building for Sustainability: a Harvard Design Magazine Reader. Minneapolis, University of Minnesota Press, 2008.
2. Stefano Corbo, "Interior Landscapes - A Visual Atlas", Images Publishing Group Pvt. Ltd., 2016.
3. M Pratap Rao, "Interior Design Principles & Practice", Standard Publishers Distributors, 2015
4. Malcolm Innes, "Portfolio Skills, Lighting for Interior Design", Laurence King Publishing Ltd., London, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/124105001/
2. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/124107006/lec1.pdf

ENLIGHTENMENT THROUGH EDUCATION SREC

20CH201 ENGINEERNG CHEMISTRY 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Make use of the concepts of electrochemistry in electrochemical devices.	PO1, PO2
CO2:	Outline the various types of corrosion and its control methods.	PO1, PO2
CO3:	Identify the analysis methods to determine the quality of fuels and air requirement for their combustion.	PO1, PO2
CO4:	Summarize the preparation, properties and uses of polymers and nanomaterials.	PO1, PO2

ELECTROCHEMISTRY AND ENERGY STORAGE DEVICES 9

Electrochemistry: Electrochemical cells -Electrode potential - Emf measurement -Nernst equation - Electrochemical series -Significance -Types of electrodes: Calomel electrode and Glass electrode.

Batteries: Types -Primary batteries, Secondary batteries - Lithium-ion battery -Speciality batteries: Nickel hydride battery, Torpedo battery -Super capacitors -Fuel cells: Proton exchange membrane fuel cell - Direct methanol-O2 fuel cell - Batteries for electric vehicles.

CORROSION AND ITS CONTROL 6

Corrosion: Impact of environment on metallic surfaces -Chemical and electrochemical corrosion -Mechanism - Factors influencing corrosion -Corrosion control - Design -Anodic and cathodic protection methods -Surface coatings - Inorganic coatings - Galvanization and Tinning - Anodization.

FUELSAND COMBUSTION 6

Fuels - Classification - Calorific value-Dulong's formula - Solid fuels -Coal - Proximate and ultimate analysis - Liquid fuel - Petroleum- Straight run petrol -Fischer Tropsch method - Octane and Cetane rating of fuels - Combustion -Theoretical air requirement for combustion.

MATERIALS CHEMISTRY 9

Polymers-Polymerization -Structure, properties and uses of industrially important polymers -PVC, Teflon, ABS, Kevlar - Composites -Characteristic properties- Classifications - FRP. Nanochemistry: Nanomaterials -Properties - Chemical Synthesis: Solgel and hydrothermal methods-Applications of nanomaterials.

Total Hours: 30

TEXT BOOKS

1. Jain P C and Monica Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publications, 2016.
2. Palanna O G, "Engineering Chemistry", 2nd Edition, McGraw Hill Publishing Company, Chennai, 2009.

REFERENCES

1. Shikha Agarwal "Engineering Chemistry: Fundamentals and Applications", 1st Edition, Cambridge University Press, 2015.

2. Shashi Chawla "A Textbook of Engineering chemistry", 3rd Edition, Dhanpat Rai Publications, 2010.

3. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" 2nd Edition, John Wiley and Sons, 2012.

WEB REFERENCES

1. http://nptel.ac.in/courses/122101001/downloads/lec-23.pdf

2. http://nptel.ac.in/courses/104105039

3. https://nptel.ac.in/courses/108/103/108103009

ENLIGHTENMENT THROUGH EDUCATION
SREC

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Relate the concepts of chemical kinetics to reaction rate and catalysis.	PO1
CO2:	Illustrate the principles of electrochemistry in electrochemical cells and corrosion.	PO1
CO3:	Summarize the preparation, properties and uses of industrially important polymers and composites.	PO1
CO4:	Utilize the analytical techniques for estimation of elements and compounds.	PO1
CO5:	Make use of the characteristic properties of propellants for suitable applications.	PO1

CHEMICAL KINETICS **5**

Basic concepts of chemical kinetics - Complex reactions - Effect of temperature onreaction rates - Catalysis.

ELECTROCHEMICAL SYSTEMS AND CORROSION SCIENCE **9**

Introduction to electrochemistry - Different types of electrodes - Half cell potential - Electromotive force - Gibbs free energy and cell potential - Nernst equation - Electrochemical series - Classification of electrochemical cells.

Corrosion: Definition - Causes and consequences - Mechanisms and theories of corrosion -Significance and methods of corrosion control.

SPECTROSCOPY **5**

Fundamentals of spectroscopy - Electronic spectroscopy - Vibrational spectroscopy - Atomic absorption spectroscopy.

PROPELLANTS **6**

Classification of propellants - Performance of propellants and thermochemistry - Liquid propellants - Oxidizers and fuels - Solid propellants - Composite solid propellants.

POLYMERS AND COMPOSITES **5**

Polymers - Polymerization- Structure, properties and uses of industrially important polymers -PVC, Teflon, ABS, Kevlar - Composites - Characteristic properties - Classifications - FRP.

Total Hours: 30

TEXT BOOKS

1. Jain P C and Monica Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publications, 2016.
2. Shikha Agarwal "Engineering Chemistry: Fundamentals and Applications", 1th Edition, Cambridge University Press, 2015.

REFERENCES

1. Shashi Chawla "A Textbook of Engineering chemistry", 3rd Edition, Dhanpat Rai Publications, 2010.
2. Naminosuke Kubota, "Propellants and Explosives: Thermochemical aspects of combustion", 3rd Edition, Wiley-VCH, 2015.
3. Dara S S., "A text book of Engineering Chemistry", 12th Edition, S.Chand & Co. Ltd., 2013.

WEB REFERENCES

1. http://nptel.ac.in/122101001/downloads/lec-25.pdf
2. http://nptel.ac.in/courses/104105039
3. https://nptel.ac.in/courses/104/106/104106122
4. https://nptel.ac.in/courses/101/106/101106082

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the various water quality parameters and their treatment methods.	PO1, PO7
CO2:	Relate the electrochemical concepts with different types of corrosion.	PO1
CO3:	Utilize the concepts of redox reactions in electrochemical cells and corrosion prevention methods.	PO1
CO4:	Apply the principles of spectroscopic methods for the estimation of elements and compounds.	PO1

WATER CHEMISTRY **9**

Introduction -Water Quality parameters: Alkalinity, Turbidity, Fluorides, Hardness- Estimation of Hardness by EDTA method-Disadvantages of hard water - Water softening and purification - External conditioning - Zeolite Process -Demineralization -Domestic water treatment-Disinfection of water-Desalination - Electrodialysis - Reverse osmosis.

ELECTROCHEMISTRY AND CORROSION **13**

Electrochemistry: Electrochemical cells -- Electrode potential - Emf measurement -Nernst equation - Electrochemical series - Significance - Types of electrodes: Calomel electrode and Glass electrode.

Corrosion: Types - Chemical and electrochemical corrosion - Mechanism - Different forms of corrosion - Intergranular, pitting, concrete, fatigue - Passivity of metals -Factors influencing corrosion- Corrosion control - Design - Anodic and cathodic Protection methods - Surface coatings - Paints - Constituents - Varnishes - Lacquers - Inorganic coatings - Galvanization and Tinning - Anodization.

ANALYTICAL TECHNIQUES **8**

Beer-Lambert's law - Colorimetry - Flame photometry - Atomic absorption spectroscopy- UV-visible spectroscopy - IR spectroscopy.

Total Hours : 30

TEXT BOOKS

1. Jain P C and Monica Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Co., 2016.
2. Palanna O. G., "Engineering Chemistry", 2nd Edition, Tata Mc.Graw Hill Education Pvt. Ltd., New Delhi, 2009.

REFERENCES

1. Dara S S., "A text book of Engineering Chemistry", 12th Edition, S.Chand & Co. Ltd., 2013.
2. Shashi Chawla, "A Textbook of Engineering chemistry", 3rd Edition, Dhanpat Rai Publications, 2010.
3. Shikha Agarwal "Engineering Chemistry: Fundamentals and Applications", 1st Edition, Cambridge University Press, 2015.

WEB REFERENCES

1. https://nptel.ac.in/content/storage2/courses/105101010/downloads/Lecture27.pdf
2. https://nptel.ac.in/courses/122/106/122106030
3. https://nptel.ac.in/courses/113/108/113108051
4. https://nptel.ac.in/courses/104/106/104106122

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Recall the concepts of electrochemistry.	PO1
CO2:	Utilize the principles of redox reactions in construction of electrochemical devices.	PO1
CO3:	Outline the preparation, properties and uses of polymers and nanomaterials.	PO1
CO4:	Make use of the characteristic properties of non-ferrous metals and alloys in engineering applications.	PO1

ELECTROCHEMISTRY AND ENERGY STORAGE DEVICES **10**

Electrochemistry: Electrochemical cells - Electrode potential - Emf measurement - Nernst equation - Electrochemical series - Significance - Types of electrodes: Calomel electrode and Glass electrode.

Batteries: Types - Primary batteries, Secondary batteries - Lithium-ion battery - Zinc-air battery - Speciality batteries: Nickel hydride battery, Torpedo battery - Super capacitors - Fuel Cells: Proton exchange membrane fuel cell - Direct methanol-O2 fuel cell.

MATERIALS CHEMISTRY **15**

Polymers - Polymerization - Structure, properties and uses of industrially important polymers - PVC - Teflon - Speciality polymers: Polycarbonate, Kevlar - Resins - Types - Thermoplastic and thermoset resins - Structure, properties and uses of ABS, PU, epoxy, vinyl ester and phenolic resins - Polymer blends and alloys - Composites - Constituents - Matrix and dispersed phases - Characteristic properties of composites - Classifications - FRP - Nanocomposites.

Nanochemistry: Nanomaterials - Chemical Synthesis -Nucleation - Mechanism of homogeneous and heterogeneous nucleation - Hydrothermal and Sol-gel methods - Properties and applications of nanomaterials.

NON FERROUS METALS AND ALLOYS **5**

Chemical composition - Properties and applications of alloys of Al and Cu - Recycling of aluminium - Super alloys - Lead alloys - Pb with Sb and Sn - Applications.

Total Hours: 30

TEXT BOOKS

1. Jain P C and Monica Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Co., 2016.
2. Gowarikar V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science", 3rd Edition, New Age International (P) Ltd., New Delhi, 2019.

REFERENCES

1. Gesser H .D, "Applied Chemistry - A Textbook for Engineers and Technologies", 1st Edition, Springer, New York, 2008.
2. Palanna O. G., "Engineering Chemistry", 2nd Edition ,Tata Mc.Graw Hill Education Pvt. Ltd., New Delhi, 2009.
3. Shashi Chawla, "A Textbook of Engineering chemistry", 3rd Edition, Dhanpat Rai Publications, 2010.

WEB REFERENCES

1. http://nptel.ac.in/courses/122101001
2. http://nptel.ac.in/courses/104105039
3. http://nptel.ac.in/courses/113105021

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply the electrochemical principles to electrochemical devices.	PO1
CO2:	Explain the mechanism of corrosion and its control methods.	PO1
CO3:	Summarize the synthesis, properties and applications of materials.	PO1
CO4:	Identify suitable spectroscopic methods for analysis of chemical compounds.	PO1
CO5:	Compare the characteristics of various solvents for cleaning electronic devices	PO1

ELECTROCHEMISTRY AND ENERGY STORAGE DEVICES **9**

Electrochemistry: Electrochemical cells - Electrode potential -Emf measurement -Nernst equation - Electrochemical series - Significance - Types of electrodes - Calomel electrode and Glass electrode.

Batteries: Types -Primary batteries, Secondary batteries - Lithium-ion battery -Speciality batteries: Nickel hydride battery, Torpedo battery -Super capacitors - Fuel Cells: Proton exchange membrane fuel cell - Direct methanol-O2 fuel cell - Batteries for electric vehicles.

CORROSION AND ITS CONTROL **6**

Corrosion: Impact of environment on metallic surfaces -Chemical and electrochemical corrosion - Mechanism - Factors influencing corrosion -Corrosion control - Design -Anodic and Cathodic protection methods -Surface coatings - Inorganic coatings - Galvanization and Tinning - Anodization.

MATERIALS AND ANALYTICAL TECHNIQUES **11**

Polymers: Introduction - Nomenclature - Polymerization - Types -Speciality polymers: Polycarbonate, Kevlar - Electronic polymers: Polyacetylene, Polythiophene - Structure, preparation, properties and uses - Composites - Types - Polymer matrix composite - FibreReinforced Plastics.

Nanochemistry: Nanomaterials - Properties - Chemical synthesis: Sol-gel and hydrothermal methods - Graphenes - Applications.

Analytical techniques:Beer-Lambert's law - Colorimetry - Ultraviolet-visible spectroscopy - Infrared spectroscopy.

CLEANING OF ELECTRONIC DEVICES **4**

Various solvents used for cleaning of electronic devices - Electronic grades - Semiconductor grades - Specifications - Merits and demerits.

Total Hours: 30

TEXT BOOKS

1. Jain P C and Monica Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Co., 2016.
2. Palanna O. G., "Engineering Chemistry", 2nd Edition ,Tata Mc.Graw Hill Education Pvt. Ltd., New Delhi, 2009.

REFERENCES

1. Shashi Chawla "A Textbook of Engineering chemistry", 3rdEdition, Dhanpat Rai Publications, 2010.
2. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, John Wiley and Sons, 2012.
3. George Wypych "Handbook of Solvents", 1st Edition, Chemtech Publishing Company, 2001.

WEB REFERENCES

1. http://nptel.ac.in/courses/122101001/downloads/lec-23.pdf
2. http://nptel.ac.in/courses/104105039
3. https://nptel.ac.in/courses/108/103/108103009

20CH207 CORROSION SCIENCE 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Summarize the various forms of corrosion.	PO1, PO2
CO2:	Explain about the thermodynamics and kinetics of corrosion.	PO1, PO2
CO3:	Identify the techniques of corrosion monitoring and testing.	PO1, PO2
CO4:	Make use of corrosion control methods in preventing corrosion.	PO1, PO2
CO5:	Summarize various surface deposition methods.	PO1, PO2

CORROSION **10**

Corrosion - Types - Atmospheric corrosion, Galvanic corrosion, Crevice corrosion, Pitting corrosion, Inter granular corrosion - Mechanically assisted corrosion - Erosion corrosion, Cavitation corrosion, Fretting corrosion - Corrosion fatigue - Environmentally induced cracking - Stress corrosion cracking -Hydrogen embrittlement-High temperature corrosion.

THERMODYNAMICS OF CORROSION **8**

Galvanic and concentration cells - Mechanism of electrochemical corrosion - Free energy criteria for corrosion reaction - Thermodynamic vs kinetic considerations - Emf and galvanic series -Pourbaix diagram of Fe and Al.

TESTING, PREVENTION AND APPLICATION **20**

Corrosion testing techniques and procedures: Weight loss method, Salt spray techniques - Electrochemical workstation: Faraday's laws -Corrosion rate expressions - Exchange current density-Activation and concentration polarization - Tafel equation - Mixed potential theory, Combined polarization -Passivity - Passivating materials - Pilling-Bedworth ratio - Protective and non-protective oxides.

Prevention of Corrosion - Design against corrosion -Modifications of corrosive environment -Inhibitors - Cathodic Protection -Protective coatings.

Corrosion of steels - Stainless steel - Aluminium alloys - Copper alloys - Nickel and Titanium alloys.

SURFACE COATING **7**

Diffusion coatings -Electro and Electroless plating -Hot dip coating - Metal spraying:Flame and Arc processes - Conversion coating -Physical Vapour Deposition:Sputter deposition process - Chemical Vapour Deposition: Atmospheric Pressure CVD and Metal Organic CVD process.

Total Hours: 45

TEXT BOOKS

1. Zaki Ahmad and Digby Macdonald, "Principles of Corrosion Engineering and Corrosion Control", 1st Edition, Butterworth-Heinemann, 2015.
2. Fontana. G., "Corrosion Engineering", 3rd Edition, McGraw Hill, New Delhi, 2017.

REFERENCES

1. Kenneth.R.Trethewey and John Chamberlain, "Corrosion for Science and Engineering", 2nd Edition, Longman Inc., 1996.
2. Rajnarayan, "Anintroduction to metallic corrosion and its prevention", 1st Edition, Oxford Publications, 1983.
3. Pietro Pedeferri, "Corrosion Science and Engineering", 1st Edition, Springer, 2018.

WEB REFERENCES

1. https://nptel.ac.in/courses/113/104/113104061
2. https://nptel.ac.in/courses/113/104/113104082/
3. https://nptel.ac.in/courses/113/108/113108051

ENLIGHTENMENT THROUGH EDUCATION SREC

20CH208 MATERIALS AND COMPOSITES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply the chemical characteristics of alloying elements on metal properties.	PO1, PO2
CO2:	Utilize the polymeric and nano functional materials in engineering applications.	PO1, PO2
CO3:	Explain the mechanical behaviour of polymer composites.	PO1, PO2
CO4:	Summarize the properties and applications of ceramics, ceramic matrix composites and refractories.	PO1, PO2

METALLIC ALLOYS **9**

Metals - Physical properties - Chemical characteristics -Role and significance of alloying elements in Fe: Ni,Cr,Mo, and W and Al: Fe, Si, Mg, Mn and Zn- Atomic absorption spectroscopy: Testing procedure and evaluation with standards.

FUNCTIONAL MATERIALS **9**

Design and application: Synthetic polymers - Carbon framework - Silicon frame work - Fluorinated polymer - Biodegradable polymers - Surfactants - Nanostructures - Soft materials and thin films - Emerging applications in energy harvesting, memory storage and micro-fabrication.

COMPOSITE MATERIALS **15**

Composites-Classification -Functional role of reinforcement and matrix phases- Importance of interface-Polymer matrix composites-FRP - Mechanical behaviour of FRP composites -Fiber controlled and matrix dependent properties -Fiber volume fraction, tensile, shear, compressive and notched strength - Fracture toughness - Non-destructive testing - Effect of environmental conditions on properties.

CERAMICS AND REFRACTORIES **12**

Ceramics -Classification - Fabrication methods of clay, Silicon Carbide, Alumina, Silicon Nitride - Properties of important engineering ceramics - Applications.

Ceramic Matrix Composites - Types - Properties - Interface - Wettability - Fabrication - Applications.

Refractories: Classification - Properties - Applications.

Total Hours: 45

TEXT BOOKS

1. Shikha Agarwal "Engineering Chemistry: Fundamentals and Applications", 1st Edition, Cambridge University Press, 2015.
2. P K Mallick, "Fiber-Reinforced Composites: Materials, Manufacturing, and Design", 3rd Edition, CRC Press, 2007.

REFERENCES

1. C. P. Sharma, "Engineering Materials: Properties and Applications of Metals and Alloys", 1st Edition, PHI, New Delhi, 2004.

2. Agarwal C.V., "Chemistry of Engineering materials", 9th Edition, B.S. Publications, 2006.

3. S.Banerjee and A.K.Tyagi, "Functional Materials", 1st Edition, Elsevier, 2011.

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1. https://nptel.ac.in/courses/113/105/113105024

2. https://nptel.ac.in/courses/112/107/112107221

3. https://nptel.ac.in/courses/113/105/113105015

4. https://nptel.ac.in/content/storage2/courses/112108092/module2/lec09.pdf

ENLIGHTENMENT THROUGH EDUCATION
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20CH209 CHEMISTRY OF ADVANCED MATERIALS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Make use of electrochemical principles in modern electronic devices.	PO1
CO2:	Summarize the properties of nanomaterials.	PO1
CO3:	Identify the suitable nanomaterials for specific applications.	PO1
CO4:	Outline the various nanostructures to be used in electroluminescent systems.	PO1

MODERN ELECTRONIC DEVICES **15**

Polymer electronics - Organic semiconductors - Organic dielectrics -Working and applications-Thin film transistors and conducting polymer based electrochemical transistors - Electrochromic devices - Components, working and applications-Advantages of nano electrical and electronic devices - Micro and nano electromechanical systems - Sensors, Actuators, Optical switches - Data memory lighting and displays - Filters (IR blocking).

NANO MATERIALS **15**

Colloids -Size and confinement effects - Size induced metal to insulator transition - Surface to volume ratio - Size effect on the lattice parameter - Energy levels in nanocrystals - Properties - Electronic, optical, magnetic, thermal, mechanical and electrochemical properties -CNT-Metal nanoparticle composites - CNT-AuNP composites - Special features and applications -Nanowires - Nanoswitches- Nanotransducers - Nanoopticalsensors.

SMART MATERIALS **15**

Nanocatalysts - Heterogeneous nanostructures and composites - Nanostructures for molecular recognition (quantum dots, nanorods) - Molecular encapsulation - Applications - Organic electroluminescent displays - Photoresists and substrates - General properties of photoresists -The wafer substrate - Substrate topography - Multilayer resist technology - Characterisation of lithographic image.

Total Hours: 45

TEXT BOOKS

1. Pulikel.M.Ajayan, "Nanocomposite Science and Technology", 1st Edition, Wiley-VCH, 2005.
2. Hagen Klauk, "Organic Electronics: Materials, Manufacturing, and Applications", 1st Edition, Wiley-VCH, 2006.

REFERENCES

1. Arnost Reiser, "Photoreactive Polymers.The Science and Technology of Resists", 1st Edition, Wiley and Sons, 1989.
2. Kohler M and Fritzsche W, "Nanotechnology: An Introduction to Nanostructuring Techniques", 2nd Edition, Wiley, 2007.
3. Fahrner Wolfgang (Ed.), "Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques", 2nd Edition, Springer-Verlag Berlin Heidelberg, 2005.

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1. https://nptel.ac.in/content/122106025/lec1.pdf
2. https://nptel.ac.in/content/112104173/Mod_1_smart_mat_lec_6.pdf
3. https://nptel.ac.in/courses/118/102/118102003

20EC203 ELECTROMAGNETIC FIELDS 3 0 0 3

PREREQUISITES

20BS201 - Physics

20MA204 - Integral and Vector Calculus

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the fundamental concepts of vector calculus and Co-ordinate systems.	PO1, PO2, PO5, PO12
CO2:	Apply the principles of electrostatics to the solutions of problems relating to electric field.	PO1, PO2, PO5
CO3:	Illustrate the behaviour of fields in materials by applying the concept of magnetostatics.	PO1, PO2, PO5
CO4:	Interpret the Maxwell's equation for time depending electromagnetic fields.	PO1, PO2, PO5
CO5:	Determine the wave equations for electromagnetic waves by using Maxwell's Equations under time varying conditions.	PO1, PO2, PO5, PO12

INTRODUCTION **9**

Review of Vector Calculus: Orthogonal Co-ordinate Systems - Line, Surface and Volume Integrals - Definition of Gradient, Divergence and Curl,-Stokes theorem and Divergence theorem.

ELECTROSTATICS **9**

Coulomb's Law- Definition of Electric Field Intensity and Electric Flux Density- Principle of Superposition - Electric Field due to various charge distributions- Gauss Law and its Applications.

Poisson's equation - Laplace's equation - Dielectrics and electric polarization - Capacitance of various geometries using Laplace's equation - Relationship between potential and electric field - Potential due to electric dipole - Electric boundary conditions.

MAGNETOSTATICS **9**

The Biot-Savart Law - Magnetic Field intensity due to a finite and infinite wire carrying a current I - Magnetic field intensity on the axis of a circular and rectangular loop carrying a current I - Magnetic flux density - Ampere's circuital law and simple applications.

The Lorentz force equation for a moving charge and applications - Force on a wire carrying a current I placed in a magnetic field - Torque on a loop carrying a current I - Inductance - Inductance of loops and solenoids - Mutual inductance - Magnetic moment - Magnetic Vector Potential - Magnetic boundary conditions.

TIME-VARYING FIELDS AND MAXWELL's EQUATIONS **7**

Faraday's law, Displacement current Density - Maxwell's equations in differential and integral form - Maxwell's equations for Time varying fields - Electromagnetic Boundary conditions - Instantaneous, average and Poynting theorem.

ELECTROMAGNETIC WAVES **11**

Wave equations and solutions - Uniform Plane Wave - Plane waves in lossless media, lossy media, Group velocity, Skin effect - Reflection and Refraction of Plane Waves - Normal and Oblique Incidences for Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle.

Case study: Simulation Study

- Vector analysis
- Co-ordinate system conversion
- Gradient, Divergence and Curl
- Electric Dipole Simulation using Coulomb's Law
- Electric field intensity and Electric flux density
- Magnetic field of a Circular current loop using Biot Savart's Law
- Ampere's Law
- Wave equation

Total Hours: 45

TEXT BOOKS

1. William H.Hayt, Jr. John A. Buck, "Engineering Electromagnetics", 9th Edition, McGraw Hill, 2019.
2. E.C. Jordan and K.G. Balmain "Electromagnetic Waves and Radiating Systems", 2nd Edition, Prentice Hall of India, 2015.
3. Mathew N. O. Sadiku, "Elements of Electromagnetics", 4th Edition, Oxford University Press, 2014.

REFERENCE BOOKS

1. Joseph A. Edminister, "Theory and Problems of Electromagnetics", Schaum Series, 2nd Edition, McGraw Hill, 2017.
2. Kraus and Fleish, "Electromagnetics with Applications", 5th Edition, McGraw Hill International Editions, 2010
3. David K Cheng, "Field and Wave Electromagnetics", 2nd Edition, Pearson Education, 2013.
4. NarayanaRao, N, "Elements of Engineering Electromagnetics", 6th edition, Pearson Education, 2004.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/106/108106073/
2. https://nptel.ac.in/courses/108/104/108104087/

20EI271 SIMULATION LABORATORY 0 0 2 1

Course Outcomes

On successful completion of the course, students will be able to

CO1:	Outline the features of mathematical functions using computational software.	PO1, PO2, PO5, PO9
CO2:	Develop a code utilizing basic commands and functions of simulation software to solve mathematical problems.	PO1, PO2, PO4, PO5, PO9
CO3:	Analyze the variables within/import into workspace of software through plots and display devices.	PO1, PO2, PO4, PO5, PO9
CO4:	Analyze the results and analysis of the experiments through reports.	PO1, PO2, PO4, PO5, P12

LIST OF EXPERIMENTS

1. Components of computational software and tool boxes
2. Mathematical operations using arrays and matrices.
3. Create and manipulate the variables for text and numeric data types.
4. Import and Export data as text files, spreadsheets, other file formats and web access.
5. Write basic programs using loops and conditional statements, such as if, for, and while.
6. Create variables within /import into Workspace of software from data files or other programs.
7. Solving Mathematical Functions using simulation tool.
8. Write basic Programs in Scripts containing sequence of commands and functions.
9. Create 2D,3D plots and display it in graphical window
10. Program to Read, Display and plot Image using open CV Library
11. Conversion of original image to Gray scale image and binary image.
12. Solving Matrices and Vectors problems using SCILAB.

20EI205 ELECTRICAL MACHINES AND DRIVES 3 0 0 3

PREREQUISITE

20EE251 - Compendium of Electrical Engineering

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Explain the construction and principle of operation of DC machines and transformer.	PO1,PO2
CO2:	Outline the features of induction and synchronous motors.	PO1, PO2
CO3:	Interpret the construction, principle of operation of special electrical machines	PO1, PO2
CO4:	Explain the operation of the converters and inverters.	PO1,PO2
CO5:	Apply power semiconductor devices for industrial applications	PO1,PO2

DC MACHINES AND TRANSFORMER **9**

DC Machines: Constructional features - Principle of operation - Types -Emf and torque equations- Characteristics of different types of motors- speed control of DC motors. Transformers: Construction and working principle -types.

AC MACHINES **9**

Three phase Induction Motor: -Construction and principle of operation - Types- Torque equation - Slip-Torque characteristics-speed control methods-Single phase Induction motor: Construction, principle of operation and types -Synchronous motor:Construction and Working principle.

SPECIAL MACHINES **6**

Stepper motors, Brushless DC motor, Permanent Magnet Synchronous motor-Linear induction motors and Servomotors.

POWER SEMICONDUCTOR DEVICES & CONVERTERS **12**

Power semiconductor devices: BJT, MOSFET, IGBT and SCR-Converters: Half, semi and fully controlled converters, Inverters:Single Phase and Three Phase inverter.

DRIVES AND ITS APPLICATION **9**

DC Drives: Single and three phase converter drives, chopper based DC drives-applications-AC drives: Induction motor drives-applications.

Total Hours: 45

TEXT BOOKS

1. Gupta J.B, "Theory and performance of Electrical Machines",14th Edition, Kataria and sons, 2010.
2. Muhamed H.Rashid, "Power Electronics Circuits, Devices and Applications",3rd Edition, Prentice Hall India Pvt. Ltd., 2014.
3. Bose.B.K. "Power Electronics and Motor Drives - Advances and Trends", 3rd Edition, Elsevier Academic Press, 2015

REFERENCE BOOKS

1. Kothari D.P., Nagrath I.J., "Electric Machine",4th Edition, McGraw Hill Publications, 2016.
2. Bimbhra P.S, "Power Electronics", 3rd Edition, Khanna Publishers, 2012.
3. G. K. Dubey, "Fundamentals of Electrical Drives" 2nd Edition , Alpha Science,2002

WEB REFERENCES

1. DC Machines:https://nptel.ac.in/courses/108/105/108105155/
2. AC machines:http://nptel.ac.in/courses/108106072/
3. Power Electronics: https://nptel.ac.in/courses/108/102/108102145/
4. Fundamentals of Electric Drives:https://nptel.ac.in/courses/108/104/108104140/

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20IT2I01 **DESIGN THINKING** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Develop a solid understanding of the fundamental phases and methods in design thinking.	PO1, PO2, PO3
CO2:	Initiate a new working culture based on a user-centric approach, empathy, ideation, prototyping, and playful testing.	PO1, PO2, PO3, PO5, PO6, PO9

Value of user-centric design - Introduction to the 5-step approach (Design Thinking) - Understand

Empathize - The bedrock of design thinking - Form teams & Identify a design challenge for each team. The design challenge (or project) to be specific to the branch of engineering that the students are studying. Department focal to provide inputs on this design challenge - Identify key stakeholders for the chosen design challenge.

Practice Empathize via field research techniques: this involves meeting with the identified stakeholders, use of tools such as journey maps, personas and empathy maps - Synthesize the data collected to define your problem statement: use of techniques to identify patterns in the data collated to help steer towards answering the questions "What are we solving? Who are we solving for?", the criticality of picking the right problem to solve.

Value of ideation using techniques such as brainstorming and brain writing - Ideate solutions for defined problem statement - Use techniques such as prioritization grid and DFV weighting to pick the top ideas - Understand Prototyping - the most effective way of communicating your idea - Prototype the top idea selected - Present the prototype to stakeholders. Test your idea with a feedback loop - Refine the prototype based on feedback - Final presentation of the refined prototype.

Total Hours: 15

REFERENCES

1. Don Norman, "Design of everyday things", 2nd Edition, Basic Books, 2013.
2. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business, 2013.

20ME203 DESIGN THINKING 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Develop design ideas and approaches using different techniques	PO1, PO2, PO3, PO6, PO9, PO10, PO12
CO2:	Apply design thinking approaches and tools to a variety of challenges and user-centric problems	PO1, PO2, PO3, PO6, PO10, PO12
CO3:	Interpret the application of tools and techniques of design thinking process along with its effects in business settings	PO1, PO2, PO3, PO6, PO10, PO12

INTRODUCTION AND IDEATION BOX

Design thinking: Definition -Need, Objectives -Five Step approach.

The Ideation Box - What's Ideation, Design Thinking - A human thing, Why - What in your opinion are some well-designed objects, features, products, solutions, etc. that people make use of often but don't pay too much attention - Discussion and Analysis.

DESIGN THINKING PHASE STEPS

The Great Products - View from Design Thinking, The Ideation Phase Steps, The Design Mind Map, The Core Phases - Discover/Define and Explore, Interview Documentation - Core Step, Opportunity Statement, Rapid Prototyping, Key Lessons.

CASE STUDIES AND TOOLS

Case Studies - 10 Industry Case Studies, how to pitch, how to reach out, Versioning / Updates, TOOLS and Techniques for Design Thinking. How design thinking changed these people/process?

Total Hours: 15

REFERENCES

1. Idris Mootee, "Design Thinking for Strategic Innovation", John Wiley & Sons, 2013.
2. Tim Brown, "Change by design, revised and update", Harper Collins publishers, 2019.
3. Design thinking crash courses and whitepapers by various organizations.

20MA201 ALGEBRA, CALCULUS AND TRANSFORMS 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Use orthogonal transformation to reduce quadratic form to canonical form.	PO1, PO2, PO5, PO9
CO2:	Construct the evolute of a curve with the principles of curvature.	PO1, PO2, PO5, PO9
CO3:	Identify the extrema of functions of two variables	PO1, PO2, PO5, PO9
CO4:	Solve the higher order ordinary differential equations.	PO1, PO2, PO5, PO9
CO5:	Apply Laplace Transform techniques in finding solutions of ordinary differential equations.	PO1, PO2, PO5, PO9
CO6:	Analyze simple electric circuits with ordinary differential equations and Laplace Transform techniques	PO1, PO2, PO5, PO9

MATRICES **12**

Characteristic equation - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors - Orthogonal transformation of a real symmetric matrix to diagonal form - Quadratic form - Nature of quadratic form - Reduction of quadratic form to canonical form by orthogonal transformation.

DIFFERENTIAL CALCULUS **8**

Curvature in Cartesian co-ordinates - Radius of curvature in Cartesian co-ordinates - Radius of curvature in parametric co-ordinates - Centre of curvature - Circle of curvature - Evolute of a curve.

FUNCTIONS OF SEVERAL VARIABLES **12**

Partial derivatives - Homogeneous functions and Euler's theorem - Total derivative - Chain rule - Composite function of one and two variables - Jacobians - Properties of Jacobians - Taylor's series expansion of functions of two variables - Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

ORDINARY DIFFERENTIAL EQUATIONS **12**

Solution of second and higher order linear differential equations with constant coefficients - Method of variation of parameters - Cauchy's and Legendre's linear differential equations - Simultaneous first order linear differential equations with constant coefficients.

LAPLACE TRANSFORMS **16**

Transform of elementary functions -Properties - Transform of derivatives and integrals - Transform of unit step function, Unit impulse function - Transform of Periodic functions - Inverse Laplace transforms - Convolution theorem - Initial and Final value theorems - Solution of linear second order ordinary differential equations with constant coefficients.

Total Hours (45L+15T) : 60

TEXT BOOKS

1. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw Hill Publications, 2017.
2. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publications, 2017.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics",10th Edition, Wiley India, 2016.
2. James Stewart, "Calculus, Early Transcendental", 7th edition, Cengage learning, 2015.
3. Ravish R. Singh and Mukul Bhatt, "Engineering Mathematics I & II", McGraw Hill Education Pvt.Limited, 2016.

WEB REFERENCES

1. https://nptel.ac.in/courses/111107108/
2. https://nptel.ac.in/courses/111105123/
3. https://nptel.ac.in/courses/111107112/

CASE STUDIES

1. List of MATLAB Programmes
    - Introduction to MATLAB.
    - Array arithmetic.
    - Assigning Variables and Manipulating Matrices.
    - Matrix Operations - Addition, Subtraction, Multiplication, Transpose and Inverse.
    - Finding Eigenvalues and Eigenvectors of Higher Order Matrices.
    - Finding curvature of a given function
    - Finding Maxima and Minima of functions of two variables.
    - Solution of second and higher order ordinary differential equations with constant coefficients
    - Evaluating Laplace and Inverse Laplace Transform of basic functions.
    - Using Laplace Transform technique to solve differential equations with constant coefficients.
2. Feature extraction of image using Principle Component Analysis.
3. Channel capacity calculation using Shannon's theorem.
4. Matrix based estimation of current and voltage for a voltage multiplier circuit.
5. Matrix based filtering techniques in Medical Image processing.
6. Analysis of velocity gradient: Fluid flow mechanics using differential calculus.
7. Solving Voltage and Current equations for transmission lines.
8. Applications of Taylor's series expansion to find continuity equation in Bipolar transistors.
9. Measurement of Deformed body mechanics using Lagrange's method.
10. Cognitive brain signal analysis using Maxwell's equation.
11. Analysis of Dynamic characteristics of Biosensors using ordinary differential equations.
12. Time response of RLC circuit using Laplace transformation in MATLAB
13. Compute the transient and steady state response of RLC electrical circuit.
14. Behaviour of Closed loop control system.
15. Analysis of RLC circuit for different conditions using Laplace Transforms.
16. Stress- strain analysis of human wrist at rotation using Laplace Transforms.

MATLAB WEB REFERENCES

1. https://www.mathworks.com
2. https://nptel.ac.in/courses/103/106/103106118/
3. https://www.khanacademy.org/tag/maxima-and-minima-math
4. https://www.khanacademy.org/math/differential-calculus

20MA202 MATRICES, DIFFERENTIAL CALCULUS AND TRANSFORMS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Use orthogonal transformation to reduce quadratic form to canonical form.	PO1, PO2, PO5, PO9
CO2:	Construct the evolute of a curve and the extrema of functions.	PO1, PO2, PO5, PO9
CO3:	Solve the higher order ordinary differential equations.	PO1, PO2, PO5, PO9
CO4:	Apply Laplace Transform techniques in finding solutions of ordinary differential equations.	PO1, PO2, PO5, PO9
CO5:	Analyze the bending of beams and simple harmonic motion with ordinary differential equations and Laplace Transform techniques.	PO1, PO2, PO5, PO9

MATRICES **9**

Characteristic equation - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors - Orthogonal transformation of a real symmetric matrix to diagonal form - Quadratic form - Nature of quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation.

DIFFERENTIAL CALCULUS **12**

Curvature in Cartesian co-ordinates - Radius of curvature in Cartesian co-ordinates - Radius of curvature in parametric co-ordinates -Centre of curvature - Circle of curvature - Evolute of a curve.

Partial derivatives - Total derivative - Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

ORDINARY DIFFERENTIAL EQUATIONS **9**

Solution of second and higher order linear differential equations with constant coefficients -Method of variation of parameters - Cauchy's and Legendre's linear differential equations - Simultaneous first order linear differential equations with constant coefficients.

LAPLACE TRANSFORMS **15**

Transform of elementary functions -Properties - Transform of derivatives and integrals - Transform of unit step function, Unit impulse function - Transform of periodic functions - Inverse Laplace transforms - Convolution theorem - Initial and Final value theorems - Solution of linear second order ordinary differential equations with constant coefficients.

Total Hours(35L+15T): 45

TEXT BOOKS

1. Veerarajan T, "Engineering Mathematics for first year", Tata McGraw Hill Publications, 2017.
2. Grewal B.S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, 2017.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2016.
2. Ravish R. Singh and Mukul Bhatt, "Engineering Mathematics I & II", McGraw Hill Education Pvt Limited, 2016.
3. Sastry S. S, "Engineering Mathematics Vol. I & II", PHI learning Pvt. Ltd, 4th Edition, 2014.

WEB REFERENCES

1. https://nptel.ac.in/courses/111107111/
2. https://nptel.ac.in/courses/111105123/

CASE STUDIES

1. List of MATLAB Programme
    - Introduction to MATLAB.
    - Array arithmetic.
    - Assigning Variables and Manipulating Matrices.
    - Matrix Operations - Addition, Subtraction, Multiplication, Transpose and Inverse.
    - Finding Eigenvalues and Eigenvectors of Higher Order Matrices.
    - Finding curvature of a given function
    - Finding Maxima and Minima of functions of two variables.
    - Solution of second and higher order ordinary differential equations with constant coefficients
    - Evaluating Laplace and Inverse Laplace Transform of basic functions.
    - Using Laplace Transform technique to solve differential equations with constant coefficients.
2. Principal planes and Principal stresses
3. Conversion of stress tensor to a diagonal matrix by orthogonal transformations (Solid mechanics).
4. Analysis of Composite material properties.
5. Displacement and stress analysis in Finite Element Techniques.
6. Determination of slope and displacement of the structures.
7. Practical problems in engineering to find maxima and minima, like costing, the beam analysis, the weight of a heat sink, maxima of flow, minimization of strain energy.
8. Relating Lagrange Method of Undetermined Multipliers to Variational Calculus applications in Finite Element Methods.
9. Optimization of mechanical structures using calculus.
10. Applications of fluid flow.
11. Boundary layer concepts.
12. Velocity and acceleration in fluids.
13. Vibration of strings with various end conditions.
14. Governing Equations of fluid flow in conservative and non-conservative form.
15. Determination of Mass and center of mass of a lamina.
16. Free vibration analysis of simple spring mass system.
17. Bending of Beams, Multi degrees of vibrating systems.
18. Approximate methods of vibration analysis.
19. Free and Force vibration analysis of simple spring mass system to find Ground motion Parameters.
20. Simple feedback control loop problems.
21. Maintenance of a constant temperature in a bath.
22. Heat transfer applications.
23. Static deflection of beams and columns.

MATLAB WEB REFERENCES

1. https://www.mathworks.com
2. https://nptel.ac.in/courses/103/106/103106118/
3. https://www.udemy.com/tutorial/learners-spot-1/lapace-transforms-and-inverse/

20MA203 LINEAR ALGEBRA AND DIFFERENTIAL CALCULUS 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Use orthogonal transformation to reduce quadratic form to canonical form.	PO1, PO2, PO5, PO9
CO2:	Identify the dimensionality of a vector spaces.	PO1, PO2, PO5, PO9
CO3:	Develop Linear transformation of vector spaces.	PO1, PO2, PO5, PO9
CO4:	Construct the evolute of a curve with the principles of curvature	PO1, PO2, PO5, PO9
CO5:	Identify the extrema of functions of two variables.	PO1, PO2, PO5, PO9
CO6:	Analyze the 2D visual representation and optimality of functions.	PO1, PO2, PO5, PO9

MATRICES **12**

Characteristic equation - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors - Orthogonal transformation of a real symmetric matrix to diagonal form - Quadratic form - Nature of quadratic form - Reduction of quadratic form to canonical form by orthogonal transformation.

VECTOR SPACE **12**

Vector spaces - Sub spaces - Bases - Linear combination - Span - linearly dependence - Independence - Dimensions - Finite dimensional - Row and column spaces - Rank and nullity.

LINEAR TRANSFORMATIONS **12**

Basic properties of linear transformations - Invertible linear transformation - Matrices of linear transformations - Vector space of linear transformation - Change of bases.

DIFFERENTIAL CALCULUS **12**

Curvature in Cartesian co-ordinates - Radius of curvature in Cartesian co-ordinates - Radius of curvature in parametric co-ordinates - Centre of curvature - Circle of curvature- Evolute of a curve.

FUNCTIONS OF SEVERAL VARIABLES **12**

Partial derivatives - Homogeneous functions and Euler's theorem -Total derivative - Chain rule - Composite function of one and two variables - Jacobians - Properties of Jacobians - Taylor's series expansion of functions of two variables- Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

Total Hours (45L+15T) : 60

TEXT BOOKS

1. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw Hill Publications, 2017.
2. Jin Ho Kwak and Sungpyo Hong, "Linear Algebra", 2nd Edition, Springer, 2004.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics",10th Edition, Wiley India, 2016.
2. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publications, 2017.
3. Stephen Andrilli and David Hecher, "Elementary Linear Algebra", 5th Edition, Academic Press, 2016.
4. Ravish R. Singh and Mukul Bhatt, "Engineering Mathematics I & II", McGraw Hill Education Pvt. Limited, 2016.

WEB REFERENCES

1. https://nptel.ac.in/courses/111107108/
2. https://nptel.ac.in/courses/111106051/
3. https://nptel.ac.in/courses/111107112/

CASE STUDIES

1. List of MATLAB Programmes
    - Introduction MATLAB.
    - Array arithmetic.
    - Assigning Variables and Manipulating Matrices.
    - Finding Operations - Addition, Subtraction, Multiplication, Transpose and Inverse.
    - Finding Eigenvalues and Eigenvectors of Higher Order Matrices.
    - Finding bases and dimensions for the vector spaces and subspaces.
    - Finding the matrix representation of a linear transformation.
    - Finding curvature of a given function.
    - Finding Maxima and Minima of functions of two variables.
2. Usage of Matrices in Cryptography.
3. Date Transmission and processing of digital signals using vector spaces.
4. 2D and 3D animations using Linear Transformations.
5. Calculus in Optimization Problems.
6. Forecasting the rate of change of disease spread using Calculus.
7. Chain Rule implementation on Artificial Neural Networks.

MATLAB WEB REFERENCES

https://www.mathworks.com

https://nptel.ac.in/courses/103/106/103106118/

https://www.khanacademy.org/tag/maxima-and-minima-math

https://www.khanacademy.org/math/differential-calculus

20MA204 INTEGRAL AND VECTOR CALCULUS 2 1 0 3

PREREQUISITE:

20MA201 Algebra, Calculus and Transforms

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Choose multiple integrals to estimate areas and volumes.	PO1, PO2, PO5, PO9
CO2:	Apply the concepts of vector integration to estimate surface areas and volumes.	PO1, PO2, PO5, PO9
CO3:	Identify analytic functions and conformal mappings.	PO1, PO2, PO5, PO9
CO4:	Solve real definite integrals expressed in terms of complex functions over contours.	PO1, PO2, PO5, PO9
CO5:	Analyze the characteristics of electromagnetic signals in a medium.	PO1, PO2, PO5, PO9

MULTIPLE INTEGRALS **12**

Double integration in cartesian and polar co-ordinates - Change of order of integration in cartesian co-ordinates - Change of variables from cartesian to polar coordinates - Triple integration in cartesian co-ordinates - Applications of multiple integrals to find areas and volumes.

VECTOR CALCULUS **12**

Gradient, Divergence and Curl - Directional derivative - Solenoidal and Irrotational vector fields - Vector integration - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem - Simple applications involving cubes and rectangular parallelopipeds.

ANALYTIC FUNCTION **9**

Analytic functions - Necessary and sufficient conditions - Cauchy-Riemann equations - Properties - Construction of analytic functions - Conformal mapping: Bilinear transformation, $w = z + c$, cz, $1/z$.

COMPLEX INTEGRATION **12**

Line Integral - Statement of Cauchy's integral theorem - Cauchy's integral formula - Taylor's and Laurent's series expansions - Singularities - Residues - Cauchy's residue theorem - Circular contour and semicircular contour integration with no pole on real axis.

Total Hours (30L+15T): 45

TEXT BOOKS

1. Veerarajan T, "Engineering Mathematics for first year", Tata McGraw Hill Publications, 2017.
2. Grewal B.S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, 2017.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2016.
2. Ravish R. Singh and Mukul Bhatt, "Engineering Mathematics I & II", McGraw Hill Education Pvt Limited, 2016.
3. Sastry S. S, "Engineering Mathematics Vol. I & II", PHI learning Pvt. Ltd, 4th Edition, 2014.

WEB REFERENCE

https://nptel.ac.in/courses/111107108/

CASE STUDIES

1. List of MATLAB Programmes
    - Evaluating double integral with constant and variable limits.
    - Finding area as double integral.
    - Evaluating triple integral with constant and variable limits.
    - Finding volume as triple integral.
    - Evaluating gradient, divergence and curl.
    - Evaluating line integrals and work done.
    - Verifying Green's theorem in the plane.
    - Exploring conformal mapping using grid lines.
    - Evaluating a complex integral.
    - Comparison of Taylor's series approximation with actual function.
    - Finding residues of a function.
2. Antenna modelling using integral equations.
3. Analysis of fields in electromagnetics.
4. Determination of response of differentiator and Integrator.
5. MATLAB programming and Simulation to find solution for Maxwell's Equation.
6. Study Rate of flow of fluid in fluid dynamics.
7. Force, Torque and velocity calculation of a moving vehicle.
8. Development of Algorithm for Coordinate transformation.
9. Analysis of average power, RMS value and power factor for one port network using analytic functions.
10. Application of Taylor's series expansion for sinusoidal and logarithmic functions.

MATLAB WEB REFERENCES

https://www.mathworks.com

https://nptel.ac.in/courses/103/106/103106118/

https://www.khanacademy.org/math/integral-calculus

20MA205 CALCULUS AND NUMERICAL METHODS 2 1 0 3

PREREQUISITE:

20MA202 Matrices, Differential Calculus and Transforms

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Choose multiple integrals to estimate areas and volumes.	PO1, PO2, PO5, PO9
CO2:	Apply the concepts of vector integration to estimate surface areas and volumes.	PO1, PO2, PO5, PO9
CO3:	Identify analytic functions and conformal mappings.	PO1, PO2, PO5, PO9
CO4:	Solve the system of linear equations numerically.	PO1, PO2, PO5, PO9
CO5:	Use numerical methods for solutions of ordinary differential equations.	PO1, PO2, PO5, PO9
CO6:	Analyze 1D fluid flow using R-K method.	PO1, PO2, PO5, PO9

MULTIPLE INTEGRALS **9**

Double integration in Cartesian and polar co-ordinates - Change of order of integration in Cartesian co-ordinates - Change of variables from Cartesian to polar coordinates - Triple integration in Cartesian co-ordinates - Applications of multiple integrals to find areas and volumes.

VECTOR CALCULUS **9**

Gradient, Divergence and Curl - Directional derivative - Solenoidal and Irrotational vector fields - Vector integration - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem - Simple applications involving cubes and rectangular parallelopipeds.

ANALYTIC FUNCTION **9**

Analytic functions - Necessary and sufficient conditions - Cauchy-Riemann equations - Properties - Construction of analytic functions - Conformal mapping: Bilinear transformation, $w = z + c$, cz, $1/z$.

NUMERICAL SOLUTION OF EQUATIONS **9**

Solution of algebraic and transcendental equations - Newton's method - Iteration method - Solution of linear system of equations: Gauss elimination - Gauss Jacobi and Gauss Seidel methods - Eigenvalue of a matrix by power method.

NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS **9**

Taylor series method - Euler and modified Euler methods- Fourth order Runge-Kutta method for solving first order equations - Milne's predictor and corrector methods.

Total Hours (30L+15T): 45

TEXT BOOKS

1. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw Hill Publications, 2017.
2. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publications, 2017.
3. Kandasamy, P, Thilagavathy, K, and Gunavathy, K, "Numerical methods" S. Chand& Company ltd., New Delhi, 2016.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2016.
2. James Stewart, "Calculus, Early Transcendental", 7th Edition, Cengage learning, 2015.
3. Ravish R. Singh and Mukul Bhatt, "Engineering Mathematics I & II", McGraw Hill Education Pvt Limited, 2016.

WEB REFERENCE

https://nptel.ac.in/courses/111105122/

CASE STUDIES

1. List of MATLAB Programmes
    - Evaluating double integral with constant and variable limits.
    - Finding area as double integral.
    - Evaluating triple integral with constant and variable limits.
    - Finding volume as triple integral.
    - Evaluating gradient, divergence and curl.
    - Evaluating line integrals and work done.
    - Verifying Green's theorem in the plane.
    - Exploring conformal mapping using grid lines.
    - Solving algebraic and transcendental equations.
    - Implementing Gauss methods to solve system of linear equations.
    - Finding numerical solutions of ordinary differential equations.
2. Volume integrals to calculate efflux of quantities from a control volume, integration of the residue over a control volume in FE and FV methods.
3. Discrete representation in terms of line, surface and volume integrals.
4. Point wise divergence free velocity field.
5. Determination of Permeability of soil.
6. Vertical stress distribution of soils.
7. Correlation between Irrotational Vector and Inviscid Flow, Solenoidal Vector and Electromagnetic Fields, Divergence theorem and its meaning in transport Phenomena.
8. Resultant forces in equilibrium of bodies.
9. Flow over an aero foil.
10. Resultant forces in equilibrium of bodies
11. Joukowski Transformation and the construction of the airfoil.
12. Governing equations of fluid flow.
13. Two Dimensional Fluid flows analysis using Cauchy Riemann Equations.
14. Air foil transformations.
15. Application of Flow nets.
16. Vibration of single / two degree of freedom system.
17. Computational Fluid Dynamics on steady and unsteady flow fields.
18. Mode Shapes in SDOF, MDOF vibrating systems.
19. Mode shapes in single degree of freedom, multi-degree of freedom vibrating systems.
20. Runge-Kutta method for one dimensional fluid flow.
21. Determination of BM of Continuous beams.
22. Deflection of beams.
23. Buckling of column failure.

MATLAB WEB REFERENCES

https://www.mathworks.com

https://nptel.ac.in/courses/103/106/103106118/

https://www.khanacademy.org/math/integral-calculus

20MA206 TRANSFORMS AND ITS APPLICATIONS 2 1 0 3

PREREQUISITE

20MA203 Linear Algebra and Differential Calculus

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Solve initial value problems with Laplace Transform techniques.	PO1, PO2, PO5, PO9
CO2:	Use Fourier Transforms to connect time and frequency domain.	PO1, PO2, PO5, PO9
CO3:	Identify Z-transform of discrete sequences.	PO1, PO2, PO5, PO9
CO4:	Apply Transform techniques in finding solutions of ordinary differential equations and difference equations.	PO1, PO2, PO5, PO9
CO5:	Analyze discrete time signals using Z-transform.	PO1, PO2, PO5, PO9

LAPLACE TRANSFORMS **12**

Transform of elementary functions -Properties - Transform of derivatives and integrals - Transform of unit step function, Unit impulse function - Transform of Periodic functions - Inverse Laplace transforms - Convolution theorem - Initial and Final value theorems

FOURIER TRANSFORMS **12**

Fourier integral theorem - Fourier transform pair - Sine and Cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

Z-TRANSFORMS **9**

Z-transform - properties - Inverse Z-transform - Initial and final value theorems - Convolution theorem.

TRANSFORM TECHNIQUES FOR SOLUTIONS OF DIFFERENTIAL EQUATIONS **12**

Solution of second and higher order linear differential equations with constant coefficients - Cauchy's and Legendre's linear differential equations. Solution of linear second order ordinary differential equations with constant coefficients using Laplace Transform. - Formation of difference equations. Solution of difference equations using Z-transform

Total Hours (30L+15T): 45

TEXT BOOKS

1. T. Veerarajan, "Transforms and Partial Differential Equations", Tata McGraw Hill Education private Ltd., New Delhi, 2016.
2. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics" Volume II, S. Chand & Company Ltd., 2016

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2016.
2. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.

WEB REFERENCE

https://nptel.ac.in/courses/111105123/

CASE STUDIES

1. List of MATLAB Programmes
    - Finding Laplace Transform and Inverse Laplace Transform of basic functions.
    - Compute Fourier and Inverse Fourier Transform of a function.
    - Finding Z-transform and Inverse Z-transform of basic functions
    - Solution of second and higher order ordinary differential equations with constant coefficients
    - Solution of Differential equations using Laplace Transform techniques
    - Solution of Difference equations using Z-transform techniques
2. Rate of change of output signals with respect to input signals using Laplace transform
3. Image analysis using Fourier transforms
4. Analysis of discrete signals using Z-transforms

MATLAB WEB REFERENCES

https://www.mathworks.com

https://nptel.ac.in/courses/103/106/103106118/

ENLIGHTENMENT THROUGH EDUCATION SREC

20MA207 INTEGRAL CALCULUS AND PARTIAL DIFFERENTIAL EQUATIONS 3 1 0 4

PREREQUISITE

20MA201- Algebra, Calculus and Transforms

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Choose multiple integrals to estimate areas and volumes.	PO1, PO2, PO5, PO9
CO2:	Apply the concepts of vector integration to estimate surface areas and volumes.	PO1, PO2, PO5, PO9
CO3:	Analyze of fluid flow in physiological vessels using vector calculus.	PO1, PO2, PO5, PO9
CO4:	Identify analytic functions and conformal mappings.	PO1, PO2, PO5, PO9
CO5:	Develop solutions of real integrals by extending complex integration.	PO1, PO2, PO5, PO9
CO6:	Solve higher order partial differential equations.	PO1, PO2, PO5, PO9

MULTIPLE INTEGRALS **12**

Double integration in cartesian and polar co-ordinates - Change of order of integration in cartesian co-ordinates - Change of variables from cartesian to polar coordinates - Triple integration in cartesian co-ordinates - Applications of multiple integrals to find areas and volumes.

VECTOR CALCULUS **12**

Gradient, Divergence and Curl - Directional derivative - Solenoidal and Irrotational vector fields - Vector integration - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem - Simple applications involving cubes and rectangular parallelopipeds.

ANALYTIC FUNCTION **12**

Analytic functions - Necessary and sufficient conditions - Cauchy-Riemann equations - Properties - Construction of analytic functions - Conformal mapping: Bilinear transformation, $w = z + c$, cz, $1/z$.

COMPLEX INTEGRATION **12**

Line Integral - Statement of Cauchy's integral theorem - Cauchy's integral formula -Taylor's and Laurent's series expansions - Singularities - Residues - Cauchy's residue theorem.

PARTIAL DIFFERENTIAL EQUATIONS **12**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of first order partial differential equations of the forms $f(p,q) = 0$, $z = px + qy + f(p,q)$ - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients.

Total Hours (45L+15T): 60

TEXT BOOKS

1. Veerarajan T, "Engineering Mathematics for first year", Tata McGraw Hill Publications, 2017.
2. Grewal B.S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, 2017.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2016.
2. Ravish R. Singh and Mukul Bhatt, "Engineering Mathematics I & II", McGraw Hill Education Pvt Limited, 2016.
3. Sastry S. S, "Engineering Mathematics Vol. I & II", PHI learning Pvt. Ltd, 4th Edition, 2014.

WEB REFERENCES

https://nptel.ac.in/courses/111107108/

https://nptel.ac.in/courses/111/105/111105093

CASE STUDIES

1. List of MATLAB Programmes.
    - Evaluating double integral with constant and variable limits.
    - Finding area as double integral.
    - Evaluating triple integral with constant and variable limits.
    - Finding volume as triple integral.
    - Evaluating gradient, divergence and curl.
    - Evaluating line integrals and work done.
    - Verifying Green's theorem in the plane.
    - Exploring conformal mapping using grid lines.
    - Evaluating a complex integral.
    - Comparison of Taylor's series approximation with actual function.
    - Finding residues of a function.
    - Solutions of second order partial differential equations.
2. Estimation of growth of microbes in a colony using definite integral method.
3. Analysis of fluid Flow in physiological & extracorporeal vessels using vector calculus.
4. CT Image based Reconstruction Techniques using analytic functions.
5. Analysis of Biosignals using Cauchy's contour integral technique.
6. Stress-Strain analysis of heart valves using partial differential equations.

MATLAB WEB REFERENCES

https://www.mathworks.com

https://nptel.ac.in/courses/103/106/103106118/

https://www.khanacademy.org/math/integral-calculus

20MA208 LINEAR ALGEBRA AND VECTOR CALCULUS 2 1 0 3

PREREQUISITE:

20MA201 Algebra, Calculus and Transforms

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify the dimensionality of a vector spaces.	PO1, PO2, PO5, PO9
CO2:	Develop linear transformation of vector spaces.	PO1, PO2, PO5, PO9
CO3:	Analyze the 2D visual representation and optimality of functions.	PO1, PO2, PO5, PO9
CO4:	Choose multiple integrals to estimate areas and volumes.	PO1, PO2, PO5, PO9
CO5:	Apply the concepts of vector integration to estimate surface areas and volumes.	PO1, PO2, PO5, PO9

VECTOR SPACE **12**

Vector spaces - Sub spaces - Bases - Linear combination - Span - linearly dependence - Independence - Dimensions - Finite dimensional - Row and column spaces -Rank and nullity.

LINEAR TRANSFORMATIONS **12**

Basic properties of linear transformations - Invertible linear transformation - Matrices of linear transformations - Vector space of linear transformation - Change of bases.

MULTIPLE INTEGRALS **12**

Double integration in Cartesian and polar co-ordinates - Change of order of integration in Cartesian co-ordinates - Change of variables from Cartesian to polar coordinates - Triple integration in Cartesian co-ordinates - Applications of multiple integrals to find areas and volumes.

VECTOR CALCULUS **9**

Gradient, Divergence and Curl - Directional derivative - Solenoidal and Irrotational vector fields - Vector integration - Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem - Simple applications involving cubes and rectangular parallelopipeds

Total Hours (30L+15T): 45

TEXT BOOKS

1. Veerarajan T., "Engineering Mathematics for first year ", Tata McGraw Hill Publications, 2017.
2. Jin Ho Kwak and Sungpyo Hong, "Linear Algebra", 2nd Edition, Springer, Re-print, 2014.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, Wiley India, 2014.
2. Stephen Andrilli and David Hecher, "Elementary Linear Algebra", 5th Edition, Academic Press, 2016.
3. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.

WEB REFERENCES

https://nptel.ac.in/courses/111106051/

https://nptel.ac.in/courses/111107108/

CASE STUDIES

1. List of MATLAB Programmes
    - Finding bases and dimensions for the vector spaces and subspaces.
    - Finding the matrix representation of a linear transformation.
    - Evaluating double integral with constant and variable limits.
    - Finding area as double integral.
    - Evaluating triple integral with constant and variable limits.
    - Finding volume as triple integral.
    - Evaluating gradient, divergence and curl.
    - Evaluating line integrals and work done.
    - Verifying Green's theorem in the plane.
2. Data Transmission and processing of digital signals using vector spaces.
3. 2D and 3D animations using Linear Transformations.

MATLAB WEB REFERENCES

https://www.mathworks.com

https://nptel.ac.in/courses/103/106/103106118/

https://www.khanacademy.org/math/integral-calculus

ENLIGHTENMENT THROUGH EDUCATION SREC

20MA210 PARTIAL DIFFERENTIAL EQUATIONS AND TENSOR CALCULUS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Solve problems involving functions of several variables in terms of partial differential equations.	PO1, PO2, PO5, PO9
CO2:	Construct the Fourier series expansion of a general periodic function	PO1, PO2, PO5, PO9
CO3:	Apply Fourier series in finding the solutions of boundary value problems	PO1, PO2, PO5, PO9
CO4:	Use numerical methods to find numerical solutions of partial differential equations	PO1, PO2, PO5, PO9
CO5:	Identify the different types of tensors	PO1, PO2, PO5, PO9
CO6:	Analyze the heat conduction of solids using partial differential equations.	PO1, PO2, PO5, PO9

PARTIAL DIFFERENTIAL EQUATIONS **9**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of first order partial differential equations of the forms $f(p,q) = 0$ and $z = px + qy + f(p,q)$ - Lagrange's linear equation - Linear homogeneous partial differential equations of second and higher order with constant coefficients.

FOURIER SERIES AND BOUNDARY VALUE PROBLEMS **18**

Dirichlet's conditions - General Fourier series - Odd and Even functions - Half range sine series and cosine series - Parseval's identity - Classification of second order quasi linear partial differential equations - Solutions of one-dimensional wave equation - One dimensional heat equation - Steady state solution of two-dimensional heat equation in cartesian coordinates.

NUMERICAL SOLUTIONS OF BOUNDARY VALUE PROBLEMS **9**

Finite difference solution of one-dimensional heat equation by explicit and implicit methods - One dimensional wave equation and two-dimensional Laplace and Poisson equations.

TENSOR CALCULUS **9**

Cartesian Tensors - Orthogonal coordinate transformation - Levi-Civita symbol - Symmetric and Anti Symmetric tensors - Tensors addition, subtraction and multiplication - Contra variant and Covariant Tensors - Equality and Null tensors

Total Hours (30L+15T): 45

TEXT BOOKS

1. Veerarajan. T, "Transforms and Partial Differential Equations", 3rd Edition, McGraw-Hill Education, 2016.
2. Kandasamy, P, Thilagavathy, K, and Gunavathy, K, "Numerical Methods", S. Chand& Company ltd., New Delhi, 2016.
3. Barry Spain, "Tensor Calculus - A concise course", Dover Publications, 2003

REFERENCES

1. Wylie C. Ray and Barrett Louis, C., "Advanced Engineering Mathematics", McGraw-Hill, Inc., New York, 2010.
2. Curtis F.Gerald, Patrick O.Wheatley, "Applied Numerical Analysis", Pearson Education, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/111107111/
2. https://nptel.ac.in/courses/111/108/111108144/

CASE STUDIES

1. List of MATLAB programme
    - Solution of linear second order partial differential equations.
    - Evaluating the Fourier coefficients
    - Solution of 1-D Heat Equation
    - Solution of 1-D Wave Equation
2. Parameterizing Wing Surfaces using Partial Differential Equations
3. Determination of Critical loads for Buckling a column
4. Mathematical models in viscoelastic and inelastic flows using Boundary Value Problems
5. Internal forces and deflections of a Beam using Boundary Value Problems
6. Plate deflection theory
7. Governing equations of Fluid Dynamics: Navier - Stokes Equations.
8. Structural Dynamics of Buildings

MATLAB WEB REFERENCE

https://in.mathworks.com

20MA211 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Solve the partial differential equations.	PO1, PO2, PO5, PO9
CO2:	Construct the Fourier series expansion of a general periodic function.	PO1, PO2, PO5, PO9
CO3:	Apply Fourier Series in finding the solutions of boundary value problems.	PO1, PO2, PO5, PO9
CO4:	Use Fourier Transform to connect time and frequency domain.	PO1, PO2, PO5, PO9
CO5:	Analyze discrete time signals using Z- transform.	PO1, PO2, PO5, PO9

PARTIAL DIFFERENTIAL EQUATIONS12

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of first order partial differential equations of the forms $f(p,q) = 0$, $z = px + qy + f(p,q)$ - Lagrange's linear equation - Linear homogeneous partial differential equations of second and higher order with constant coefficients.

FOURIER SERIES AND BOUNDARY VALUE PROBLEMS12

Dirichlet's conditions- Complex Fourier series - General Fourier series- Odd and Even functions - Half range sine series and cosine series - Parseval's identity - Harmonic Analysis.

Classification of second order quasi linear partial differential equations - Solutions of one dimensional wave equation.

FOURIER TRANSFORMS12

Fourier transform - Inverse Fourier transform - Fourier Sine and Cosine transforms -Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

Z TRANSFORMS9

Z transform - Elementary properties- Inverse Z transform - Convolution theorem - Formation of difference equations - Solution of difference equations using Z transform.

Total Hours (30L+15T): 45

TEXT BOOKS

1. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics" Volume III, S. Chand & Company Ltd., 2011.
2. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, 2014.

REFERENCES

1. Wylie C. Ray and Barrett Louis C., "Advanced Engineering Mathematics", 6th Edition, McGraw Hill Inc., 2005.
2. Churchill R.V. and Brown J.W., "Fourier Series and Boundary Value Problems", 7th Edition, McGraw Hill Book Co., 2006.
3. Simon Haykin and Barry Van Veen, "Signals and Systems", 2nd Edition, John Wiley and Sons, 2007.

WEB REFERENCE

https://onlinecourses.nptel.ac.in/noc17_ma06/course

CASE STUDIES

1. List of MATLAB programme
    - Solution of linear second order partial differential equations.
    - Evaluating the Fourier coefficients
    - Solution of 1-D Wave Equation
    - Evaluating Fourier and Inverse Fourier Transform of elementary functions.
    - Evaluating Z transforms and Inverse Z transforms.
2. Solution to partial differential equations in electromagnetic fields.
3. Solutions of Fourier series representation of Half wave rectifier and Harmonic Analysis.
4. Verification of properties of convolution.

MATLAB WEB REFERENCE

https://in.mathworks.com

ENLIGHTENMENT THROUGH EDUCATION SREC

20MA212 COMPUTATIONAL METHODS IN ENGINEERING - I 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Analyze statistical data using measures of central tendency, correlation and regression lines.	PO1, PO2, PO5, PO9
CO2:	Infer the outcome of a random experiment using probability techniques	PO1, PO2, PO5, PO9
CO3:	Develop the concept of differentiation and integration numerically	PO1, PO2, PO5, PO9

STATISTICS **15**

Measures of central tendency - Variance and Standard deviation - Correlation - Karl Pearson's Coefficient of Correlation - Regression - Regression coefficients - Regression lines- ANOVA-One way and Two way Classification.

PROBABILITY **15**

Random variable - Discrete Random variable- Probability distributions- Probability mass function - Cumulative distribution function- Expectation- Moment generating function- Binomial and Poisson distributions. Continuous Random variables- Probability distributions- Probability density function - Cumulative distribution function - Expectation- Moment generating functions- Exponential and Normal distributions.

APPROXIMATIONS **3**

Accuracy and Precision - Definitions of round off and Truncation errors-error propagation

NUMERICAL METHODS **12**

Fitting of straight line, fitting of parabola and exponential curve by the principle of least square method- Interpolation - Newton's forward and backward interpolation - Lagrange's interpolation - Newton's Divided difference interpolation-Derivatives using Newton's forward and backward interpolation - Numerical integration by Simpson's 1/3 and 3/8 rules.

Total Hours: (30L+15T):45

TEXT BOOKS

1. Sheldon M.Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier India Private Ltd, 2016.
2. Steven C.Chapra, Raymond P. Canale, "Numerical Methods for Engineers", McGraw Hill Education India Private Ltd, seventh edition, 2016.
3. T.Veerarajan, T.Ramachandran, "Statistics & Numerical Methods" McGraw Hill Publications Co. Ltd., Chennai, 2018.

REFERENCES

1. Gupta S.C. and Kapoor V.K, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2018.
2. Ronald E.Walpole, Raymond H.Myers & Sharon L.Myers, "Probability & Statistics for Engineers and Scientists", Prentice Hall of India Private Ltd, 1998.

3. Gerald .C.F. and Wheatley .P.O., "Applied Numerical Analysis", Seventh Edition, Pearson Education, Asia, New Delhi, 2007.

WEB REFERENCES

1. https://nptel.ac.in/courses/111/106/111106112/
2. https://onlinecourses.swayam2.ac.in/cec21_ma09/preview

CASE STUDIES

1. List of MATLAB Programmes
    - Introduction to descriptive statistics and data distributions.
    - Fit linear and nonlinear models to data.
    - Compare the sample means of multiple groups and find statistically significant difference between Groups. One-way and Two-way ANOVA.
    - Calculating Interpolated and Extrapolated Values.
    - Solution of Numerical Integration.
2. Application of error propagation to a robot's odometry model.
3. Solving robot joint distributions using MATLAB.
4. Compute convolution-like integrals that arise in robot kinematics and motion planning.
5. Solve a set of coupled linear or nonlinear algebraic equations using software.

MATLAB WEB REFERENCE

https://www.mathworks.com

20MA213 NUMERICAL METHODS 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Solve the system of Linear equations numerically.	PO1, PO2, PO5, PO9
CO2:	Develop the interpolating function for a given data.	PO1, PO2, PO5, PO9
CO3:	Solve differentiation and integration numerically.	PO1, PO2, PO5, PO9
CO4:	Use numerical methods for solutions of Differential Equations.	PO1, PO2, PO5, PO9
CO5:	Analyze biological system using R-K method.	PO1, PO2, PO5, PO9

SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 16

Solution of algebraic and transcendental equations - Regula- Falsi method - Newton's method - Solution of linear system by Gaussian elimination and Gauss-Jordon methods - Inverse of a matrix by Gauss Jordon method - Iterative methods: Gauss Jacobi and Gauss-Seidel methods - Eigen value of a matrix by power method.

INTERPOLATION 08

Newton's forward and backward interpolation - Lagrange's interpolation - Newton's Divided difference interpolation.

NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Derivatives using Newton's forward and backward interpolation - Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules - Two and Three point Gaussian quadrature formula -Double integrals using trapezoidal and Simpson's rule.

INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods: Taylor series method - Euler and Modified Euler methods - Fourth order Runge-Kutta method for solving first and second order equations - Multistep methods: Milne's and Adam's predictor and corrector methods.

BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference solution of second order ordinary differential equation - Finite difference solution of one dimensional heat equation by explicit and implicit methods - One dimensional wave equation and two dimensional Laplace and Poisson equations.

Total Periods (45L + 15T): 60

TEXT BOOKS

1. Kandasamy P., Thilagavathy K., and Gunavathy K., "Numerical Methods", S.Chand Co. Ltd., New Delhi, 2016.
2. Gerald C.F. and Wheatley P.O., "Applied Numerical Analysis", 7th Edition, Pearson Education, India, 2012.

REFERENCES

1. Veerarajan T., Ramachandran T., "Numerical Methods", McGraw Hill Education Private Ltd., 2019.

2. Burden R.L., and Faires T.D., "Numerical Analysis", 10th Edition, Thomson Asia Pvt. Ltd., 2016.

3. Steven C. Chapra., Raymond P. Canale., "Numerical Methods for Engineers", McGraw Hill Education Private Ltd., 2016.

WEB REFERENCES

1. nptel.ac.in/courses/111/107/111107105/
2. nptel.ac.in/courses/127/106/127106019/

CASE STUDIES

1. List of MATLAB Programme
    - Solution of Linear system of equations
    - Newton's forward and backward interpolation
    - Numerical integration using Trapezoidal and Simpson's rule
    - Solution of Ordinary differential equation using Runge-Kutta method
    - Numerical Solution of 2D-heat equation
2. Steady state behavior of biological linear systems.
3. Dynamic behavior of Biological systems.
4. Dynamics of membrane and nerve cell potentials.

MATAB WEB REFERENCES

1. https://in.mathworks.com
2. https://skill-lync.com/projects/Numerical-Solution-of-2D-Heat-equation-using-Matlab-35339

20MA214 DISCRETE STRUCTURES AND COMBINATORICS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply the knowledge of Boolean algebra in design of digital computers.	PO1, PO2, PO5, PO9
CO2:	Demonstrate relations and functions along with their properties	PO1, PO2, PO5, PO9
CO3:	Apply the rules of mathematical logic for deriving logical conclusions	PO1, PO2, PO5, PO9
CO4:	Use the concepts of combinatorics in solving linear recurrence relations	PO1, PO2, PO5, PO9

RELATIONS AND FUNCTIONS **18**

Relations- Equivalence relations- Partial order relation -Relational matrix and the graph of a relation - Hasse diagram-Lattices and their properties-Boolean algebra- Functions -Types of functions-composition of functions - inverse of a function-Characteristic function-Recursive functions.

MATHEMATICAL LOGIC **15**

Equivalence and implication - Basic laws- Normal forms-PCNF and PDNF -Proofs in Propositional calculus - Quantifiers-Free and bound variables-Valid formulas and equivalences-Inference theory of predicate calculus.

COMBINATORICS **12**

Basics of counting - Counting arguments - Permutations and Combinations -Permutation with repetition-circular permutation- Pigeonhole principle- Principle of Inclusion and exclusion -Recurrence relations - Particular solutions -Solving linear recurrence relations.

Total Periods (30L + 15T): 45

TEXTBOOKS

1. Ralph P. Grimaldi, B.V. Ramana "Discrete and Combinatorial Mathematics an Applied Introduction", Pearson Education Asia, 5th Edition 2013.
2. T. Veerarajan, "Discrete Mathematics", Tata McGraw Hill Publishing co, 2nd Edition 2019.

REFERENCES

1. Kenneth H. Rosen, " Discrete Mathematics and Its Applications", Tata McGraw Hill, Seventh Edition, 2015.
2. Trembly J.P. and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 35th Re-print, 2008.
3. S. Lipschutz and M. L. Lipson. - Schaum's Outline of " Discrete Mathematics" -Prentice-Hall, 3rd Edition, 2007.

WEB REFERENCE

https://onlinecourses.nptel.ac.in/noc20_cs82/preview

CASE STUDIES

1. List of MATLAB Programms
   - Simplification of Boolean function using Boolean algebra.
   - Generate the series using recursive relation.
   - Compute all the possible permutations and combinations.
2. Database query design and processing.
3. Design of programming languages with basic data structures.
4. Analysis of algorithms and Optimization of algorithms

MATLAB WEB REFERENCE

https://in.mathworks.com

20MA215 PROBABILITY AND STATISTICS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify an appropriate probability distribution for a given random variable.	PO1, PO2, PO5, PO9
CO2:	Interpret the interdependence of two decision variables through regression.	PO1, PO2, PO5, PO9
CO3:	Compute confidence intervals associated with sample and population.	PO1, PO2, PO5, PO9
CO4:	Analyze the variance using ANOVA	PO1, PO2, PO5, PO9

PROBABILITY DISTRIBUTIONS AND STATISTICS 15

Discrete distribution: Geometric distribution and its properties-Continuous distributions: Uniform, Exponential, Gamma, and Normal distributions and their properties - Karl Pearson's coefficient of correlation -Rank Correlation-Regression - Regression coefficients - Regression lines .

SAMPLING THEORY 18

Testing of hypothesis - Large sample tests: Test of significance for single proportion, difference of proportions, single mean and difference of means - Small sample tests: t- test for single mean and difference of means, F- test for variances-Chi-square test for goodness of fit and independence of attributes.

DESIGN OF EXPERIMENTS 12

Analysis of variance in one way classification - Analysis of variance in two way classification - Completely randomized design - Randomized block design

Total Periods (30L+15T): 45

TEXT BOOKS

1. Sheldon M. Ross, "Probability and Statistics for Engineers and Scientists", Elsevier India Private Ltd, 6th Edition, 2020.
2. Veerarajan T., "Probability, Statistics and Random Processes (with queueing theory and queueing networks)", 4th Edition, Tata McGraw Hill, 2015.

REFERENCES

1. Neil A. Weiss, "Introductory Statistics", Pearson Education, 10th Edition, 2017.
2. Ronald E. Walpole, Raymond H. Myers and Sharon L. Myers, "Probability & Statistics for Engineers and Scientists", Prentice Hall of India Private Ltd 9th Edition,2017.
3. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2014.

WEB REFERENCE

1. https://nptel.ac.in/courses/111/105/111105090/

CASE STUDIES

1. List of MATLAB programmes
    - Generate random samples from geometric distribution
    - Fit curves to data using regression.
    - Finding Correlation coefficients.
    - Testing of null hypothesis.
    - Compute the pdf of F-Distribution.
2. Analysis of risk management and its prediction.
3. Test for detecting untruthful answering.
4. Optimality in production engineering.

MATLAB WEB REFERENCE

https://in.mathworks.com

ENLIGHTENMENT THROUGH EDUCATION SREC

20MA216 PROBABILITY AND QUEUEING THEORY 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify an appropriate probability distribution for a given random variable.	PO1, PO2, PO5, PO9
CO2:	Interpret the interdependence of two decision variables through regression.	PO1, PO2, PO5, PO9
CO3:	Demonstrate random process and Markov chain.	PO1, PO2, PO5, PO9
CO4:	Apply the basic characteristic features in queuing models.	PO1, PO2, PO5, PO9

PROBABILITY DISTRIBUTIONS **9**

Discrete distribution: Geometric distribution and its properties-Continuous distributions: Uniform, Exponential, Gamma, and Normal distributions and their properties.

TWO DIMENSIONAL RANDOM VARIABLES **12**

Joint distributions - Marginal and conditional distributions - Covariance - Correlation - regression - regression coefficients - regression lines - Central limit theorem.

RANDOM PROCESSES AND MARKOV CHAINS **12**

Classification - Stationary process - Markov process - Poisson process -- Markov chains - Transition probabilities - Limiting distributions.

QUEUEING THEORY **12**

Characteristics of Queuing Models - Poisson Queues - (M/M/1): (FIFO/∞), (M/M/1): (FIFO/N), (M/M/C): (FIFO/∞), ((M/M/C): (FIFO/N) models

Total Periods (30L + 15T): 45

TEXT BOOKS

1. Veerarajan., T., "Probability, Statistics and Queuing Theory", Tata McGraw-Hill, Second Edition, New Delhi, 2016.
2. Sheldon M. Ross, "Probability and Statistics for Engineers and Scientists", Elsevier India Private Ltd, 6th Edition, 2020.

REFERENCES

1. Taha, H.A., "Operations Research-An Introduction", Seventh Edition, Pearson Education Edition Asia, Delhi, 2011.
2. Allen., A.O., "Probability, Statistics and Queuing Theory", Academic press, New Delhi, 2nd Edition, 2014.
3. Gross, D. and Harris, C.M., "Fundamentals of Queuing theory", John Wiley and Sons, Fourth Edition, New York, 2011.

WEB REFERENCE

https://nptel.ac.in/courses/111/104/111104079/

CASE STUDIES

1. List of MATLAB Programme
   - Generate random samples from geometric distribution
   - Computation of mean and standard deviation using Normal distribution
   - Finding Correlation coefficients
   - Fit curves to data using regression.
   - Create Markov chain using matrix of Transition probabilities
2. Signal modulation and demodulation, calculation of insurance risk
3. Implications in communication theory.
4. Cryptography and crypt analysis
5. Scheduling and resource sharing in computer operating systems and analysis of computer networks

MATLAB WEB REFERENCE

https://in.mathworks.com

20MA217 TRANSFORMS, PROBABILITY AND STATISTICS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply Fourier transforms to connect the time domain and frequency domain	PO1, PO2, PO5, PO9
CO2:	Solve difference equations using Z transforms.	PO1, PO2, PO5, PO9
CO3:	Analyze the probability distributions to depict the expected outcome of a random experiment.	PO1, PO2, PO5, PO9
CO4:	Identify the interdependence of two decision variables through regression	PO1, PO2, PO5, PO9
CO5:	Analyze the frequency response of discrete time system using Z -Transforms	PO1, PO2, PO5, PO9

FOURIER TRANSFORMS **12**

Fourier integral theorem - Fourier transform pair - Sine and Cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

Z-TRANSFORMS **12**

Z-transform - Elementary properties - Inverse Z-transform - Convolution theorem - Formation of difference equations - Solution of difference equations using Z transform.

PROBABILITY **12**

Probability distributions - Discrete distributions - Geometric distribution - Continuous distributions - Uniform, Exponential, Gamma, Weibull and Normal distributions.

STATISTICS **9**

Curve fitting - Fitting a straight line, parabola and exponential curve by Method of Least Squares - Karl Pearson's coefficient of correlation - Spearman's rank correlation - Regression - Regression coefficients - Regression lines.

Total Periods (30L + 15T): 45

TEXT BOOKS

1. Veerarajan. T, "Transforms and Partial Differential Equations" 3rd Edition, McGraw-Hill Education, 2016
2. Gupta S.C. and Kapur J.N., "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand, 2016.
3. Veerarajan T., "Probability, Statistics and Random Processes", 2nd Edition, Tata McGraw-Hill, 2016.

REFERENCES

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, Wiley India, 2014.
2. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, 2014.
3. Kandasamy P., Thilagavathy K., and Gunavathy K., "Engineering Mathematics" Volume III, S.Chand & Company ltd., 2016.

WEB REFERENCES

1. https://nptel.ac.in/courses/111105041/
2. https://nptel.ac.in/courses/111/106/111106112/

CASE STUDIES

1. List of MATLAB programme
    - Evaluating Fourier and Inverse Fourier Transform of elementary functions.
    - Evaluating Z transforms and Inverse Z transforms.
    - Fit curves to data using regression.
    - Finding Karl Pearson and Spearman's Correlation coefficients
2. The periodic variation of gas pressure in a 4-stoke internal combustion engine using Fourier Transform.
3. Predicting system oscillation using Fourier transforms.
4. Simulate the continuous systems using Z-transforms.
5. Finding frequency response of the system using Z - transforms.
6. Population and sampling distribution in aviation/aircraft industries
7. Structural acoustic analysis using the Fast Fourier transforms.
8. Aircraft parameter identification using Fourier transforms.
9. Formation of a linear regression equation for the prediction of surface roughness of a turned work piece.
10. Frequency analysis of vibrating system.

MATLAB WEB REFERENCES

1. https://matlabacademy.mathworks.com/R2020b/portal.html?course=stats
2. https://in.mathworks.com

ENLIGHTMENT THROUGH EDUCATION ★ SREC ★

20MA218 PROBABILITY, STATISTICS AND NUMERICAL METHODS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify the distribution to assess the data.	PO1, PO2, PO5, PO9
CO2:	Construct regression lines using correlation co-efficient.	PO1, PO2, PO5, PO9
CO3:	Analyze the attributes of the population by studying the sample drawn from it.	PO1, PO2, PO5, PO9
CO4:	Solve the linear system of equations numerically.	PO1, PO2, PO5, PO9
CO5:	Use numerical methods for the solutions of Ordinary differential equations.	PO1, PO2, PO5, PO9

PROBABILITY DISTRIBUTIONS AND STATISTICS **15**

Discrete distribution: Geometric distribution and its properties-Continuous distribution: Uniform distribution, Gamma distribution, Exponential distribution and Normal distribution and their properties. Curve Fitting: Fitting of straight line, fitting of parabola and exponential curve by the principle of least square method - Karl Pearson's coefficient of correlation-Regression-Regression coefficients-Regression lines.

TESTING OF HYPOTHESIS **15**

Testing of hypothesis - Large sample tests - Test of significance for single proportion, Difference of proportions, Single mean and difference of means - Small sample tests: t- test for single mean and difference of means, F-test for variances-Chi square test for goodness of fit and independence of attributes.

NUMERICAL SOLUTIONS FOR LINEAR EQUATIONS AND ORDINARY DIFFERENTIAL EQUATIONS **15**

Solution of algebraic and transcendental equation - Newton's method - Solution of linear system by Gauss elimination and Gauss Jordon methods - Iterative methods: Gauss Jacobi and Gauss Seidel methods. Solution of first order differential equations: Taylor series method, Euler and modified Euler methods, Fourth order Runge Kutta method.

Total Periods (30L+ 15T): 45

TEXT BOOKS

1. Veerarajan T., "Probability, Statistics and Random Processes", Tata McGraw Hill, 2016.
2. Gerald C.F. and Wheatley P.O., "Applied Numerical Analysis", 7th Edition, Pearson Education Asia, 2009.

REFERENCES

1. Ross S., "A first Course in Probability", 9th Edition, Pearson Education, 2014.
2. Gupta S.C., and Kapur V.K., "Fundamentals of Mathematical Statistics", 12th Edition , Sultan Chand, 2016.
3. Kandasamy P., Thilagavathy K., and Gunavathy K., "Numerical Methods", S. Chand Co. Ltd., 2016.

WEB REFERENCE

https://onlinecourses.nptel.ac.in/noc16_ma03/preview

CASE STUDIES

1. List of MATLAB Programme
    - Construction of probability density function of geometric distribution.
    - Computation of mean and standard deviation using Normal distribution
    - Polynomial curve fitting
    - Small and large sample t test
    - Statistical significance using f test
    - Solution of linear system of equation using Gauss elimination
    - Solution of Ordinary differential equation using Euler method
2. Power system stability.
3. Analysis of variances in circuits.
4. Load flow Analysis.
5. Error Analysis in measurement system.
6. Noise and Vibration measurements.
7. Discretization of I and II order systems using Runge-Kutta method.

MATLAB WEB REFERENCE

https://in.mathworks.com

ENLIGHTENMENT THROUGH EDUCATION SREC

20MA219 PROBABILITY AND RANDOM PROCESSES 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply the concept of probability in distributions.	PO1, PO2, PO5, PO9
CO2:	Construct the regression lines for two dimensional random variable.	PO1, PO2, PO5, PO9
CO3:	Identify discrete and continuous random processes and summarize its properties.	PO1, PO2, PO5, PO9
CO4:	Analyze the spectral density of a random process.	PO1, PO2, PO5, PO9

PROBABILITY DISTRIBUTIONS **15**

Moments - Moment generating functions and their properties. Geometric, Uniform, Exponential, Gamma and Normal distributions and their properties.

TWO DIMENSIONAL RANDOM VARIABLE **12**

Joint distributions - Marginal and conditional distributions - Transformation of random variables - Central limit theorem - Covariance - Coefficient of correlation - Regression - Regression coefficients - Regression lines.

RANDOM PROCESSES AND SPECTRAL DENSITIES **18**

Stochastic processes - Classification - Stationary Processes, Wide sense stationary and Ergodic processes - Auto correlation - Cross correlation - Properties - Markov, Binomial, Poisson and Sine wave processes. Introduction to Power spectral density - Cross spectral density - Properties - Wiener-Khintchine relation - Auto correlation and cross correlation functions of input and output.

Total Periods (30L + 15T): 45

TEXT BOOKS

1. Veerarajan T., "Probability and Statistics, Random Processes and Queueing Theory", Tata McGraw-Hill, 2019.
2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 6th Edition, Elsevier India Pvt. Ltd Education, 2010.

REFERENCES

1. Peyton Z. Peebles and Bertram Emil Shi, "Probability Random Variables and Random Signal Principles", 4th Edition, Tata McGraw-Hill Publishers, 2015.
2. Kandasamy P., Thilagavathy K. and Gunavathy K., "Probability, Statistics and Random Process" S.Chand & Co., 2010.
3. Oliver Ibe, "Fundamentals of Applied Probability and Random Processes", 2th Edition, Academic Press, 2014.

WEB REFERENCES

1. https://nptel.ac.in/courses/117/105/117105085/
2. https://nptel.ac.in/courses/117/103/117103067/

CASE STUDIES

1. List of MATLAB Programme
   - Generate random samples from geometric distribution
   - Computation of mean and standard deviation using Normal distribution
   - Finding Correlation coefficients.
   - Fit curves to data using regression.
2. Applications of auto and cross correlation.
3. Removal of noise using correlation.

MATLAB WEB REFERENCE

1. https://in.mathworks.com

20MA220 COMPUTATIONAL METHODS IN ENGINEERING- II 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, the student will be able to

CO1:	Formulate the LPP problem and use the various techniques to find the optimal solution	PO1, PO2, PO5, PO9
CO2:	Solve integer programming models using branch and bound and Gomory's techniques.	PO1, PO2, PO5, PO9
CO3:	Apply search methods to find the optimum value of multivariable functions.	PO1, PO2, PO5, PO9
CO4:	Determine optimal solutions using evolutionary algorithms for robust design problems	PO1, PO2, PO5, PO9
CO5:	Use the classical optimization methods to solve the constrained optimization theory for continuous problems	PO1, PO2, PO5, PO9
CO6	Use the optimization techniques to determine the solutions for robot path planning problems	PO1, PO2, PO5, PO9

LINEAR PROGRAMMING PROBLEMS **12**

Mathematical Formulation of Linear Programming Problems - Graphical solution and Optimization outcomes- Simplex search for linear programming. Transportation Problem - Optimal solution by MODI method- Assignment problem - Hungarian method.

INTEGER PROGRAMMING **12**

Formulation of Integer Programming models -Gomory's all integer programming problem - Gomory's mixed integer programming problem - Branch and bound technique.

MUTIVARIABLE OPTIMIZATION ALGORITHMS **12**

Unconstrained Multivariable Optimization - Unidirectional Search - Direct Search Methods - Box's Evolutionary Optimization Method - Simplex Search Method - Hooke - Jeeves Pattern Search Method - Gradient-based Methods - Cauchy's (Steepest Descent) Method - Marquardt's Method - Conjugate Gradient Method

EVOLUTIONARY ALGORITHMS **12**

Genetic Algorithm (GA)- Working Principles- Difference between GAs and Traditional methods- Similarities between GAs and traditional methods- GAs for constrained optimization- Selection of Simulated annealing parameters- Simulated Annealing algorithm (SA); Global optimization-Using Simulated Annealing- Examples - Global Optimization using Particle Swarm Optimization (PSO) - Examples.

NON LINEAR PROGRAMMING PROBLEM **12**

Classical optimization- Unconstrained problem of Maxima and Minima-Constrained - Kuhn- Tucker conditions - Solution of Unconstrained Non-Linear Programming Problem by using One Dimensional Search Procedure and the Gradient Search Procedure.

Total Hours (45L+15T):60

TEXT BOOKS

1. S.S.Rao, "Engineering Optimization-Theory and Practice", John Wiley and sons Inc., Fifth edition, 2019.
2. H.A.Taha, "Operation Research", Prentice Hall of India, Tenth edition 2017.
3. KantiSwarup, P.K.Gupta, Manmohan, "Operations Research", Sultan Chand & sons - 2020.

REFERENCES

1. Fredrick S.Hillier, Gerald J. Liebermann, "Introduction to Operations Research", McGraw-Hill, Ninth edition, 2014.
2. J.K.Sharma, "Operations Research Theory and Applications", MacMillan Business Books, Third edition-2006.
3. Kalyanmoy Deb, "Optimization for Engineering: Design-Algorithms and Examples", PHI second edition, 2012.

WEB REFERENCE

1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ma29\
2. https://nptel.ac.in/courses/112/106/112106064/\
3. https://nptel.ac.in/courses/111/105/111105100/

CASE STUDIES

1. List of MATLAB Programmes
    - Solving linear programming problems using Simplex algorithm.
    - Solving an Integer Programming problem.
    - Find minimum of function using genetic algorithm.
    - Solving constrained or unconstrained nonlinear problems with one or more objectives.
2. Using LP method, solve for the problem of dynamic target pursuit and obstacle avoidance using software.
3. Solving multi-robot path planning using MATLAB.
4. Solving mobile robot path planning through GA using software.
5. Solving real-time position control of an industrial robot using software.

MATLAB WEB REFERENCE

https://www.mathworks.com

20MA221 OPTIMIZATION TECHNIQUES 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Formulate and solve real life situations involving linear variables.	PO1,PO2,PO5,PO9
CO2:	Optimize the non-linear function subject to the constraints.	PO1, PO2, PO5, PO9
CO3:	Use search methods to find the optimum value of multivariable functions.	PO1, PO2, PO5, PO9
CO4:	Apply the decision making process in real life situations	PO1, PO2, PO5, PO9
CO5	Analyze the basic characteristic features in queuing models.	PO1, PO2, PO5, PO9

LINEARMODELS1 **2+4**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP-Simplex Method-Artificial Variable Techniques-BigM method.

NONLINEARPROGRAMMING **6+2**

Unconstrained problems - necessary and sufficient conditions - constrained problems- equality constraints-inequality constraints-Kuhn-Tucker conditions.

CONVEXOPTIMIZATION **9+3**

Random search method - Univariate method - Gradient of a function -Cauchy's Steepest Descent Method - Conjugate gradient method.

DECISION ANALYSIS **6+2**

Introduction-Decision making problem-Decision making under certainty-Decision under uncertainty -Decisions under risk

QUEUINGMODELS **12+4**

Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models :(M/M/1): (FIFO/?), (M/M/1): (FIFO/N), multiple service channel models: (M/M/C):(FIFO/?),((M/M/C):(FIFO/N).

Total Periods (45L +15T): 60

TEXT BOOKS

1. TahaH.A.,"Operations Research",8thEdition,Prentice Hall of India,2011.
2. KantiSwarup, Gupta P.K. and Manmohan, "Operations Research", Sultan Chand & Sons, 2010.
3. Veerarajan., T., "Probability, Statistics and Queuing Theory", Tata McGraw-Hill, Second Edition, New Delhi, 2016.

REFERENCE BOOKS

1. Fredrick S. Hillier and Gerald J. Liebermann, "Introduction to Operations Research", 8thEdition, McGraw Hill, 2011.
2. Anderson,"Quantitative Methods for Business", 10th Edition, Thomson Learning,2009.
3. Sharma J.K., "Operations Research Theory and Applications", 3rd Edition, Business Books, 2006.
4. Kalyanmoy Deb, "Optimization for Engineering: Design-Algorithms and Examples", PHI,Second edition, 2012.

WEB REFERENCES

1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ma29\
2. https://nptel.ac.in/courses/112/106/112106064/
3. https://nptel.ac.in/courses/111/105/111105100/

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Illustrate the generation of laser and ultrasonic waves to be used for engineering applications.	PO1
CO2:	Summarize the types of optical fibers and crystal systems.	PO1, PO5, PO12
CO3:	Outline the miller indices and d-spacing of cubic systems and the significance of photonic sensors.	PO1
CO4:	Apply the modes of heat transfer to appraise the conductivity of materials.	PO1, PO5, PO12

PHOTONICS **10**

LASERS: Characteristics of Laser - spontaneous emission - stimulated emission - Types of lasers - Generation - CO2 - Nd -YAG laser - Applications: 3D profiling, Material processing.

FIBER OPTICS: Principle - Structure - Modes of propagation - Classification based on materials and refractive index profile - Applications of Photonic sensors: Temperature, Pressure and Displacement measurement.

CRYSTAL PHYSICS AND ULTRASONICS **12**

CRYSTAL PHYSICS: Introduction - Lattice - Bravais Lattice - Lattice Planes - Miller Indices - d-spacing in cubic lattice - Relation between miller indices and d-spacing of a cubic system - Cubical Crystal System - Types - SC, BCC, FCC and HCP structures - Calculation of Co-ordination number, Number of atoms per unit cell - Atomic radius and Atomic Packing Factor - Crystal defects : Point, Line and Surface defects.

ULTRASONICS: Ultrasonic waves - properties - production - Magnetostriction - Piezoelectric - Applications: Drilling, Welding, Cleaning and Non-destructive testing.

THERMAL PHYSICS **8**

Transfer of heat energy - thermal expansion of solids and liquids - expansion joints - bimetallic strips - thermal conduction - convection and radiation - heat conductions in solids - thermal conductivity - Forbe's and Lee's disc method - conduction through compound media - series and parallel - thermal insulation - applications: heat exchangers - refrigerators - ovens and solar water heaters.

Total Hours : 30

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.
2. Bhattacharya D.K. and Poonam T, "Engineering Physics", Oxford University Press, 2015.

REFERENCES

1. Charles Kittel, "Introduction to Solid State Physics", Wiley India Pvt. Ltd, 7th ed., 2012.
2. Dattu R.Joshi, "Engineering Physics", Tata McGraw- Hill, New Delhi, 2010.
3. William D.Callister Jr, David G. Rethwisch "Materials Science and Engineering - An Introduction", Wiley India (P) Ltd., 8th Edition, 2018.

WEB REFERENCES

1. https://nptel.ac.in/courses/104104085/
2. http://nptel.ac.in/courses/122107035/
3. http://nptel.ac.in/courses/112104026/
4. http://nptel.ac.in/courses/115107095/
5. https://nptel.ac.in/courses/112106227/

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Classify sound waves and types of optical fibers for aeronautical engineering applications.	PO1, PO5
CO2:	Outline the properties of sound absorbing materials and dual nature of matter.	PO1
CO3:	Illustrate the generation of ultrasonic waves and laser for engineering applications.	PO1, PO5
CO4:	Apply the modes of heat transfer to appraise the conductivity of the materials.	PO1, PO5

ACOUSTICS AND ULTRASONICS **10**

Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - calculation of reverberation time for different types of buildings - sound absorbing materials - factors affecting acoustics of buildings : focussing, interference, echo, echelon effect, resonance - noise and their remedies. Ultrasonics: production - magnetostriction and piezoelectric methods - detection of ultrasound - acoustic grating - ultrasonic interferometer - industrial applications - Non- destructive testing - ultrasonic method: scan modes and practice.

APPLIED OPTICS **10**

Interference - Michelson interferometer: construction, working, determination of wave length and thickness - anti-reflection coating - air wedge and its applications - Lasers - principle and applications - Einstein's coefficients - CO2 and Nd:YAG laser - semiconductor lasers: homo junction and hetro junction - construction and working - applications. Optical fibres - classification based on index and mode - principle and propagation of light in optical fibres - acceptance angle and numerical aperture - fibre optic communication system - active and passive sensors.

THERMAL AND MODERN PHYSICS **10**

Thermal expansion - thermal stress - expansion joints - bimetallic strips - thermal conductivity- heat conductions in solids - flow of heat through compound media - Forbe's and Lee's disc method: theory and experiment- Black body radiation - Planck's theory (derivation) - Compton effect - wave model of radiation and matter - Schrödinger's wave equation - time dependent and independent equations - Physical significance of wave function - particle in a one dimensional box.

Total Hours: 30

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.
2. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.

REFERENCES

1. Halliday, D., Resnick, R. and Walker, J. "Principles of Physics". Wiley, 2020.
2. William D.Callister Jr, David G. Rethwisch "Materials Science and Engineering - An Introduction", Wiley India (P) Ltd., 8th Edition, 2018.

3. Charles Kittel, "Introduction to Solid State Physics", Wiley India Pvt. Ltd, 7th ed., 2012.
4. Dattu R.Joshi, "Engineering Physics",Tata McGraw- Hill,New Delih,2010.
5. Pandey, B.K. and Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/104104085/
2. http://nptel.ac.in/courses/122107035/
3. http://nptel.ac.in/courses/122107035/
4. http://nptel.ac.in/courses/115107095/
5. https://nptel.ac.in/courses/112106227/
6. https://nptel.ac.in/courses/113106070/

ENLIGHTENMENT THROUGH EDUCATION SREC

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Illustrate the generation of laser and ultrasonics along with their applications.	PO1, PO5
CO2:	Classify the types of sound waves and optical fiber with their applications.	PO1
CO3:	Relate stress-strain behaviour with mechanical properties of materials and reverberation time with acoustics of buildings.	PO1
CO4:	Apply non-destructive testing and photonic sensor for structural health monitoring.	PO1, PO5

PHOTONICS **8**

LASERS: Characteristics of Laser - Principle of spontaneous emission and stimulated emission - Types of lasers - Principle, Construction, Working, Properties, Merits, Demerits and applications of CO2 and Nd-YAG laser - Applications: 3D profiling - Ranging and Survey.

FIBER OPTICS: Principle- Structure - Modes of propagation - Classification based on materials and refractive index profile - Photonic sensors - Temperature and Displacement measurement.

PROPERTIES OF MATTER **7**

ELASTICITY: Stress-Strain diagram - Fracture - Yield Point - Yield Strength - Ductility - Hardness - Mohs Scale - Toughness - Malleability - Vicker's Hardness test.- Rigidity modulus - Torsional Pendulum - Young's modulus - Cantilever and Non-uniform bending

ACOUSTICS **7**

ACOUSTICS: Classification of sound - Characteristics of musical sound -Weber-Fechner law - Reverberation time - Absorption coefficient and its determination -Factors affecting acoustics of buildings - Remedies - Acoustical Holography.

ULTRASONICS AND NON DESTRUCTIVE TESTING **8**

ULTRASONICS : Introduction - Production - Magnetostriction generator - Piezoelectric generator - Detection of ultrasonics - Properties - Acoustical Grating - Cavitation - Pulse echo method - ultrasonic imaging.

NON-DESTRUCTIVE TESTING : Classification of Testing Materials - Liquid Penetrant Testing - Radiography - Ultrasonic Testing - Thermography.

Total Hours: 30

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.
2. William D.Callister Jr, David G. Rethwisch "Materials Science and Engineering - An Introduction", Wiley India (P) Ltd., 8th Edition, 2018.

REFERENCES

1. Brain Culshaw, "Smart Structure and Materials", Artech House, 2th Edition, 2004.
2. Halliday, D., Resnick, R. and Walker, J. "Principles of Physics". Wiley, 2020.

WEB REFERENCES

1. https://ocw.mit.edu/courses/materials-science-and-engineering/
2. http://nptel.ac.in/courses/122107035/
3. https://nptel.ac.in/courses/104104085/
4. http://nptel.ac.in/courses/115107095/
5. https://nptel.ac.in/courses/105105177/

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Show the motion of oscillations and waves using two dimensional differential equations.	PO1
CO2:	Extend the concept of lasers and optical fibres for engineering applications.	PO1
CO3:	Outline the image formation using ultrasonic and adaptive optics.	PO1, PO5
CO4:	Apply the energy distribution equation using interference and diffraction.	PO1, PO5

OSCILLATORY MOTION **8**

Simple harmonic motion - Velocity damping - Damping coefficient - Differential equation of SHM - Velocity and acceleration - Restoring force - Vibration of a spring and mass system - Frequency response, phase response and resonance - Analogy with LCR circuits - Energy and energy loss - Vibration and vibration isolation

WAVE MOTION **8**

Definition of a plane progressive wave - Attenuation of waves - Representation of waves using complex numbers - Differential equation of a plane progressive wave - Phase velocity - Phase and phase difference - Solution of the differential equation of a plane progressive wave - Differential equation of 2-dimensional wave motion - Introduction to numerical methods for solution of wave equation

PHOTONICS AND ULTRASONICS **7**

Lasers: population of energy levels - Semiconductor lasers

Optical Fiber: principle - numerical aperture and acceptance angle - types of optical fibres - material - refractive index - mode - fibre optic sensors - pressure and displacement-

Ultrasonics :Production - Magnetostriction and Piezoelectric generator - Detection of ultrasonics - Properties - Acoustical Grating - ultrasonic imaging.

WAVE OPTICS **7**

Image formation using lenses and mirrors - Adaptive optics - Fresnel mirrors - Tracking - Interference and diffraction - Single and double slits- Interpretation of the energy distribution equation in single and double slit patterns - Principle of Michelson's interferometer - Applications - Spectral distribution.

Total Hours: 30

TEXT BOOKS

1. Bhattacharya D.K. and Poonam, T- "Engineering Physics" Oxford University Press, 2015
2. Gaur R K and Gupta S L "Engineering Physics"- Dhanpat Rai Publishers, 2018

REFERENCES

1. Halliday D Resnick R and Walker J, "Principles of Physics"- Wiley, 2020
2. Serway R A and Jewett JW, "Physics for Scientists and Engineers"- Cengage Learning, 2010
3. Pandey B K and Chaturvedi, S "Engineering Physics"- Cengage Learning India, 2012

WEB REFERENCES

1. https://nptel.ac.in/courses/115106119/
2. https://nptel.ac.in/courses/104104085/
3. http://nptel.ac.in/courses/122107035/
4. http://nptel.ac.in/courses/112104026/
5. http://nptel.ac.in/courses/115107095/
6. https://nptel.ac.in/courses/108106135/

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Extend the principles of laser and optical fiber for communications.	PO1
CO2:	Illustrate the concepts of ultrasonics, vacuum technology, nanomaterials and their applications.	PO1, PO5
CO3:	Explain the fabrication techniques of integrated circuits.	PO1
CO4:	Apply the properties of engineering materials for device applications.	PO1, PO5

PHOTONICS **6**

Lasers : Semiconductor laser - Applications - 3D Profiling.

Fiber Optics - Principle - Structure - Derivation of acceptance angle and numerical aperture - applications - fiber optical communication - Fiber optic sensors - Temperature and Displacement measurement.

CONDUCTING, SUPERCONDUCTING AND SEMICONDUCTING MATERIALS **10**

Classical theory - Derivation - co-efficient of electrical and thermal conductivity - Wiedemann Franz law - Contact potential - Materials and alloys for high conductivity - Superconductivity - BCS theory of superconductivity (qualitative) - Types of superconductors - properties - High Tc superconductors - Application of superconductors - SQUID, Cryotron - Semiconductors - Hall Effect - Hall voltage - Hall coefficient - Experimental verification - Integrated Circuit Fabrication - Manufacturing Process of Monolithic ICs - Thick and Thin Film Technology.

MAGNETIC AND INSULATING MATERIALS **6**

Ferromagnetism - Ferrites - Magnetic materials used in machines, instruments and relays - Dielectric Materials - Ferroelectric materials - Piezoelectric - Pyroelectrics - Inorganic materials - Organic materials - Liquid insulators - Ageing of Insulators

ULTRASONICS AND VACUUM TECHNOLOGY **4**

Piezoelectric generator - Detection - Acoustical Grating - Applications - Non-Destructive Testing (NDT) - Vacuum pumps - Rotary - Diffusion - Gauges - Penning gauges

NANO MATERIALS **4**

Top down process - Ball milling - Bottom up process - Physical Vapour Deposition (PVD) - Chemical Vapour Deposition (CVD) - Carbon Nanotube (CNT) - Fullerenes - Properties and applications.

Total Hours: 30

TEXT BOOKS

1. Avadhanalu M N and Kshirsagar P G, "A Textbook of Engineering Physics", S. Chand and Company Ltd, 11th edition, 2018.

2. Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.

REFERENCES

1. Rao V V, Ghosh T B and Chopra K L, "Vacuum Science and Technology", Allied Publishers Limited, 2008.
2. Charles Kittel, "Solid State Physics", John Wiley and Sons, 8th Edition, 2012.
3. Indulkar .C.S and Thiruvengadam.S, "Introduction to Electrical Engineering Materials", S.Chand and Company, 6th Revised Edition, 2011.

WEB REFERENCES

1. https://nptel.ac.in/courses/104104085/
2. http://nptel.ac.in/courses/122107035/
3. http://nptel.ac.in/courses/112104026/
4. http://nptel.ac.in/courses/115107095/
5. https://www.electrical4u.com/electrical- Engineering-materials/
6. https://nptel.ac.in/courses/113105025/

ENLIGHTENMENT THROUGH EDUCATION SREC

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Extend the principles of mechanics and behaviour of fluid motion for biological systems.	PO1, PO5
CO2:	Classify the different types of optical radiation and crystal systems.	PO1
CO3:	Outline the effect of electromagnetic radiation on biological tissues.	PO1
CO4:	Apply the properties of ultrasonic waves in fluids for imaging.	PO1, PO5

PREREQUISITE: Nil

BASICS OF MECHANICS **8**

Kinematics and Dynamics: Displacement, Velocity and Acceleration - Uniform Circular Motion, Relative Motion - Force, Newton's Laws of Motion and Law of Gravitation - Principle of Superposition - Equilibrium of Forces - Linear Momentum, Conservation of Linear Momentum - Impulse.

Work and Energy: Work done by a Constant Force and a Variable Force; Kinetic Energy and Work-Energy Theorem, Potential Energy and Conservative Forces, Energy Diagrams; Elastic and Inelastic Collisions - Power - Work and Power in human movements.

Angular Motion: Angular Displacement, Angular Velocity and Angular Acceleration - Dynamics of Angular Motion - Torque - Angular Momentum - Torque in human bone joints

FLUIDS **6**

Viscosity - Co-efficient of critical velocity - Poiseuille's formula for co-efficient of viscosity and its correction - Determination of co-efficient of viscosity - Variations of viscosity with temperature and pressure - Viscosity of gases - Mayer's formula for the rate of flow of a gas through a capillary tube -Rankine's method for the determination of viscosity of a gas. Newtonian and Non Newtonian fluids. Fluid behaviour of blood.

ELECTRO MAGNETIC RADIATIONS **6**

Radiation - Types of radiation - Ionization and Excitation - Interaction of radiation with matter - reflection - refraction - interference - diffraction - rectilinear propagation of light - polarisation - plane - circularly - elliptically polarised light - Kerr effect and Optical activity

Linear energy transfer - Attenuation -attenuation co-efficient - Biological effects of radiation - Direct and indirect effects: chronic and acute effects - Biological effect of Microwave and RF wave - Thermal and non-thermal effects on whole body - Types of optical radiations - UV, visible and IR - Optical properties of tissues - Applications of optical radiations in detection and treatment of skin disorders - Medical applications of Lasers.

ULTRASONICS **5**

Production - Magnetostriction generator - Piezoelectric generator - Detection of ultrasonics - Properties - Acoustical Grating - Cavitation- Acoustic Impedance - Non-Destructive Testing - Pulse echo method - ultrasonic imaging -Medical Applications.

CRYSTAL PHYSICS **5**

Lattice - Bravais Lattice - Lattice Planes - Miller Indices - d-spacing in cubic lattice - Relation between miller

indices and d-spacing of a cubic system - Cubical Crystal System - Types - SC, BCC, FCC and HCP structures - Calculation of Co-ordination number, Number of atoms per unit cell - Atomic radius and Atomic Packing Factor - Crystal defects - Point, Line and Surface defects - Role of imperfection in electrical, mechanical and optical properties.

Total Hours: 30

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", DhanpatRai Publications, 2018.
2. Herman Cember, Thomas E Johnson. "Introduction to Health Physics", McGraw Hill, 5th Edition, 2017.

REFERENCES

1. KiruthigaSivaprasath andMurugesan R., "Properties of Matter and Acoustics", S.Chand and Company, 2005.
2. Avadhanalu M N, and Kshirsagar P G, "A Textbook of Engineering Physics", S.Chand& Company Ltd, 2018.
3. Johns and Cunningham, "The Physics of Radiology", Thomas, 4th Edition, 1983.

WEB REFERENCES

1. https://www.khanacademy.org/science/physics/torque-angular-momentum
2. http://www.eng.ucy.ac.cy/cpitris/courses/ECE477/presentations/English/05.%20Tissue%20Optics.pdf
3. https://www.khanacademy.org/science/physics/fluids#fluid-dynamics
4. http://nptel.ac.in/courses/113106032/4%20-%20Crystal%20structure.pdf
5. https://nptel.ac.in/courses/112106227/

20PH214 BIOPHYSICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Extend the principles of mechanics and behaviour of fluid motion for biological systems.	PO1, PO5
CO2:	Classify the different types of optical radiation and crystal systems.	PO1
CO3:	Outline the effect of electromagnetic radiation on biological tissues.	PO1
CO4:	Apply the properties of ultrasonic waves in fluids for imaging.	PO1, PO5

PREREQUISITE: Nil

BASICS OF MECHANICS **12**

Kinematics and Dynamics: Displacement, Velocity and Acceleration - Uniform Circular Motion, Relative Motion - Force, Newton's Laws of Motion and Law of Gravitation - Principle of Superposition - Equilibrium of Forces - Linear Momentum, Conservation of Linear Momentum - Impulse.

Work and Energy: Work done by a Constant Force and a Variable Force; Kinetic Energy and Work-Energy Theorem, Potential Energy and Conservative Forces, Energy Diagrams; Elastic and Inelastic Collisions - Power - Work and Power in human movements.

Angular Motion: Angular Displacement, Angular Velocity and Angular Acceleration - Dynamics of Angular Motion - Torque - Angular Momentum - Torque in human bone joints

FLUIDS **9**

Viscosity - Co-efficient of critical velocity - Poiseuille's formula for co-efficient of viscosity and its correction - Determination of co-efficient of viscosity - Variations of viscosity with temperature and pressure - Viscosity of gases - Mayer's formula for the rate of flow of a gas through a capillary tube -Rankine's method for the determination of viscosity of a gas. Newtonian and Non Newtonian fluids. Fluid behaviour of blood.

ELECTRO MAGNETIC RADIATIONS **9**

Radiation - Types of radiation - Ionization and Excitation - Interaction of radiation with matter - reflection - refraction - interference - diffraction - rectilinear propagation of light - polarisation - plane - circularly - elliptically polarised light - Kerr effect and Optical activity

Linear energy transfer - Attenuation -attenuation co-efficient - Biological effects of radiation - Direct and indirect effects: chronic and acute effects - Biological effect of Microwave and RF wave - Thermal and non-thermal effects on whole body - Types of optical radiations - UV, visible and IR - Optical properties of tissues - Applications of optical radiations in detection and treatment of skin disorders - Medical applications of Lasers.

ULTRASONICS **6**

Production - Magnetostriction generator - Piezoelectric generator - Detection of ultrasonics - Properties - Acoustical Grating - Cavitation- Acoustic Impedance - Non-Destructive Testing - Pulse echo method - ultrasonic imaging -Medical Applications.

CRYSTAL PHYSICS **9**

Lattice - Bravais Lattice - Lattice Planes - Miller Indices - d-spacing in cubic lattice - Relation between miller

indices and d-spacing of a cubic system - Cubical Crystal System - Types - SC, BCC, FCC and HCP structures - Calculation of Co-ordination number, Number of atoms per unit cell - Atomic radius and Atomic Packing Factor - Crystal defects - Point, Line and Surface defects - Role of imperfection in electrical, mechanical and optical properties.

Total Hours: 45

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", DhanpatRai Publications, 2018.
2. Herman Cember, Thomas E Johnson. "Introduction to Health Physics", McGraw Hill, 5th Edition, 2017.

REFERENCES

1. KiruthigaSivaprasath andMurugesan R., "Properties of Matter and Acoustics", S.Chand and Company, 2005.
2. Avadhanalu M N, and Kshirsagar P G, "A Textbook of Engineering Physics", S.Chand& Company Ltd, 2018.
3. Johns and Cunningham, "The Physics of Radiology", Thomas, 4th Edition, 1983.

WEB REFERENCES

1. https://www.khanacademy.org/science/physics/torque-angular-momentum
2. http://www.eng.ucy.ac.cy/cpitris/courses/ECE477/presentations/English/05.%20Tissue%20Optics.pdf
3. https://www.khanacademy.org/science/physics/fluids#fluid-dynamics
4. http://nptel.ac.in/courses/113106032/4%20-%20Crystal%20structure.pdf
5. https://nptel.ac.in/courses/112106227/

20PH207 NANO AND SMART MATERIALS 3 0 0 3

PREREQUISITE:

20PH201- Engineering Physics

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the size dependent phenomena at nano scale	PO1
CO2:	Illustrate the various fabrication methods of nanostructures for engineering applications.	PO1, PO5, PO12
CO3:	Apply various characterization techniques to assess the structural, morphological and optical properties of nanomaterials.	PO1, PO5, PO12
CO4:	Summarize the properties and applications of smart materials and carbon-based nanomaterials.	PO1

BASICS AND SCALE OF NANOTECHNOLOGY **12**

Definition of a nanosystem - Dimensionality and size dependent phenomena - Surface to volume ratio - Fraction of surface atoms - Surface energy and surface stress - surface defects - Properties at nanoscale: optical, mechanical, electronic and magnetic properties.

CLASSIFICATION AND FABRICATION OF NANOSTRUCTURES **13**

Classification based on dimensionality - Quantum Dots, Wells and Wires- Carbon based nano materials -buckyballs - nanotubes - graphene-Top Down and Bottom Up Process: Metal Nanocrystals by Reduction - Solvothermal Synthesis -Photochemical Synthesis - Sonochemical Routes - Chemical Vapor Deposition (CVD) - Metal Oxide Chemical Vapor Deposition (MOCVD) - Ball Milling - Electrodeposition - Spray Pyrolysis - Flame Pyrolysis - DC - RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE).

CHARACTERIZATION TECHNIQUES AND APPLICATIONS OF NANOSTRUCTURES **12**

X-Ray Diffraction (XRD) - Scanning Electron Microscopy (SEM) -Transmission Electron Microscope (TEM) - Atomic Force Microscopy (AFM) - Ultraviolet Absorption and Photoluminescence Technique -Solar energy conversion and catalysis - Applications: Sensors - Carbon nanotubes - Fullerenes.

SMART MATERIALS **8**

Introduction to Smart materials - Actuator and actuator materials - Piezoelectric and Electrostrictive material - Magnetostrictive material - Shape memory alloys (SMA) - Phases - Shape memory effect - Pseudoelastic effect - Ni-Ti alloys - Applications: Precision equipment for automobiles

Total Hours: 45

TEXT BOOKS

1. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Cao G.Z, Wang Y, "Nanostructures &Nanomaterials: Synthesis, Properties & Applications", World Scientific Publishing, 2nd Edition, 2011.

REFERENCES

1. Poole C.P, Owens FJ, "Introduction to Nanotechnology", John Wiley and Sons, 1st Edition, 2011.
2. Pradeep T, "Nano: The essentials - Understanding Nanoscience and Technology", Tata McGraw-Hill, 2007.
3. Dupas C., Houdy P., Lahmani M., "Nanoscience: Nanotechnologies and Nanophysics", Springer, 2007.

WEB REFERENCES

1. http://www.understandingnano.com/nanomaterials.html
2. http://nanoyou.eu/attachments/188_Module-1-chapter-7-proofread.pdf
3. http://webdocs.cs.ualberta.ca/~database/MEMS/sma_mems/sma.html
4. https://nptel.ac.in/courses/118104008/
5. https://nptel.ac.in/courses/112104251/

ENLIGHTENMENT THROUGH EDUCATION SREC

20PH208 ESSENTIALS OF MATERIALS SCIENCE 2 0 0 2

PREREQUISITE:

20PH202-Waves and Optics

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Relate the stress - strain behaviour of materials used for aerospace applications.	PO1
CO2:	Explain the moduli of elasticity of materials.	PO1, PO5
CO3:	Summarize the crystal systems and defects for selection of aerospace materials.	PO1
CO4:	Apply the knowledge of ceramics, composites, furnishing materials and shape memory alloys in aerospace design.	PO1

PROPERTIES OF MATTER **6**

Elasticity - Poisson's ratio and relationship between moduli (qualitative) - stress-strain diagram for ductile and brittle materials, uses - factors affecting elastic modulus and tensile strength - bending of beams - cantilever - bending moment - Young's modulus determination - theory and experiment - uniform and non-uniform bending - I shaped girders - twisting couple - hollow cylinder - shaft - torsion pendulum - determination of rigidity modulus-moment of inertia of a body (regular and irregular).

CRYSTALS **6**

Single crystalline, polycrystalline and amorphous materials - Single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices - interplanar distance for a cubic crystal - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - structure and significance of NaCl, CsCl, ZnS and graphite - crystal imperfections: point defects, line defects - Burger vectors, dislocations and stacking faults - Growth of single crystals: Bridgman and Czochralski methods.

AEROSPACE MATERIALS **6**

Structure of solid materials - Atomic and lattice structure - x-ray diffraction - Imperfection in crystals - Physical metallurgy- General requirements of materials for aerospace applications - Strain hardening - Creep and fatigue.

FURNISHING MATERIALS **6**

Plastic - Wood - Rubber in aircraft manufacture - Methods of testing and storage - Paints - Surface finishes - Specifications: Indian standard - British - American and International Standards.

CERAMICS AND COMPOSITES **6**

Introduction - Powder metallurgy - Modern ceramic materials - Cements - Cutting tools - Glass ceramic - Production of semi-fabricated forms - Plastics and rubber - Carbon composites - Fibre reinforced composite materials - Fabrication processes involved in metal matrix composites - Shape memory alloys - Applications in aerospace vehicle design.

Total Hours: 30

TEXT BOOKS

1. Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.
2. Avadhanalu M N and Kshirsagar P G, "A Textbook of Engineering Physics", S. Chand and Company Ltd, 2018.

REFERENCES

1. Shackelford, J.F., Introduction to Materials Science for Engineers, 7th edition, Prentice Hall PTR, Paramus, NJ, 2009.
2. Titterton G., "Aircraft Materials & Processes", Sterling Book House, 5th Edition, 1998.
3. Van Vlack L. H., "Elements of Materials Science and Engineering", Pearson, 6th Edition, 1994.

WEB REFERENCES

1. https://en.wikipedia.org/wiki/Aerospace_materials
2. https://en.wikipedia.org/wiki/Aircraft
3. nptel.ac.in/courses/101104010/
4. nptel.ac.in/courses/113105057/
5. https://www.electrical4u.com/electrical- Engineering-materials

ENLIGHTENMENT THROUGH EDUCATION SREC

20PH209 NANO AND QUANTUM PHYSICS 3 0 0 3

PREREQUISITE:

20BS201- Physical Sciences

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the basics of Nanotechnology and Quantum mechanics used for quantum computing.	PO1, PO5
CO2:	Summarize the dual nature of matter waves and quantum heterostructures for data transfer applications.	PO1
CO3:	Apply the properties of ultra-low dimensional materials towards the functionality of primary devices. .	PO1, PO5
CO4:	Explain the concept of nano in fabricating electronic devices.	PO1

BASICS OF NANOTECHNOLOGY **6**

Introduction -Surface to Volume Ratio - Size Dependent Properties at Nanoscale -Top-down and Bottom-up approaches.

QUANTUM PHYSICS **8**

Inadequacies of Classical Mechanics - Duality nature of electromagnetic radiation - De Broglie hypothesis for matter waves - Heisenberg's uncertainty principle -Schrödinger's wave equation - Particle confinement in 1D box (Infinite Square well potential) - Bit and Qubit - Quantum dot cellular automata.

BASICS OF QUANTUM MECHANICS **9**

Photelectric effect - Raman effect - Postulates of Quantum Mechanics - States and operators - Hilbert space - Dirac's bra and ket notations - Stark effect - Zeeman effect

OPTICAL AND ELECTRICAL PROPERTIES **7**

Introduction to physical properties of nanomaterials - Melting points and lattice constants - Surface Plasmon resonance - Quantum size effects - Surface scattering - Quantum transport - Effect of microstructure.

NANOELECTRONICS **7**

Quantum Mechanical Tunneling - Single Electron Box - Single Electron Devices and Transistors - Logic Circuits Using Molecules - Nanowire Diodes, Transistors and Interconnects - Nanorobotics and Nanomanipulation.

APPLICATIONS **8**

Flexible and Plastic Electronics - Carbon Nanotube Electronics - LEDs Based on Nanowires, Nanotubes and Nanorods - Lasers Based on Nanodots and Nanowires - Nanocomputers - Wearable Technology - MEMS - NEMS based data storage.

Total Hours: 45

TEXT BOOKS

1. Avadhanalu M N, and Kshirsagar P G, "A Textbook of Engineering Physics", S. Chand and Company Ltd, 2018.
2. Bhattacharya D.K. and Poonam T, "Engineering Physics", Oxford University Press, 2015.
3. Cao G.Z, Wang Y, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", World Scientific Publishing, 2nd Edition, 2011.

REFERENCES

1. Poole C.P, Owens FJ, "Introduction to Nanotechnology", John Wiley and Sons, 1st Edition, 2011.
2. Nielsen, Michael A.; Chuang, Isaac L. "Quantum Computation and Quantum Information", Cambridge University Press, 2010.
3. Petty M. C., "Molecular Electronics: From Principles to Practice", John Wiley & Sons, Ltd., 2007.
4. Vishal Sahni et.al. "Nanocomputing: The future of computing", Tata McGraw - Hill Education, 2008.
5. Pradeep T, "Nano: The essentials - Understanding Nanoscience and Technology", Tata McGraw-Hill, 2007.

WEB REFERENCES

1. https://nptel.ac.in/courses/118104008/
2. https://nptel.ac.in/courses/122106034/
3. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/lecture-videos/
4. https://nptel.ac.in/courses/117108047/

ENLIGHTENMENT THROUGH EDUCATION SREC

20PH210 ESSENTIALS OF QUANTUM PHYSICS 3 0 0 3

PREREQUISITE:

20BS201-Physical Sciences

COURSE OUTCOMES

On successful completion of the course- students will be able to

CO1:	Extend the solution of Schrodinger's wave equation for ground state energy of hydrogen atom and spherically symmetric potentials.	PO1, PO5
CO2:	Illustrate the fundamental equations and the properties of molecules based on various models.	PO1, PO5
CO3:	Explain the quantum mechanical postulates and bonding principles using wave function.	PO1
CO4:	Apply the equation of wave function for numerical solutions of one dimensional problems.	PO1

WAVE NATURE OF PARTICLES AND SCHRODINGER'S EQUATION 10

Introduction to Quantum mechanics - Wave nature of Particles - Time-dependent and time independent Schrodinger equation for wavefunction - Born interpretation- probability current - Expectation values - Free-particle wavefunction and wave-packets - Uncertainty principle.

Photoelectric effect - Raman effect - Postulates of Quantum Mechanics - States and operators - Hilbert space - Dirac's bra and ket notations - Stark effect - Zeeman effect

PRELIMINARIES FOR QUANTUM MECHANICS 6

Complex numbers- Linear vector spaces - inner product - operators - eigenvalue problems - Hermitian operators- Hermite polynomials - Legendre's equation - spherical harmonics.

APPLICATIONS OF SCHRODINGER'S EQUATION 15

Solution of stationary - state Schrodinger equation for one dimensional problems - particle in a box - particle in attractive delta-function potential- square-well potential - linear harmonic oscillator - Numerical solution of stationary - state Schrodinger equation for one dimensional problems for different potentials Scattering from a potential barrier and tunnelling - related examples like alpha-decay - field ionization and scanning tunneling microscope Three dimensional problems: particle in three dimensional box and related examples - Angular momentum operator - Rigid Rotor - Hydrogen atom ground state - orbitals - interaction with magnetic field - spin Numerical solution stationary - state radial Schrodinger equation for spherically symmetric potentials

MOLECULAR BONDING AND MODELS 14

Particle in double delta-function potential - Molecules (hydrogen molecule - valence bond and molecular orbitals picture) - singlet/triplet states - chemical bonding - hybridization

Free electron theory of metals - Fermi level - density of states - Application to white dwarfs and neutron stars - Bloch's theorem for particles in a periodic potential - Kronig-Penney model and origin of energy bands Numerical solution for energy in one - dimensional periodic lattice by mixing plane waves.

Total Hours: 45

TEXT BOOKS

1. Avadhanalu M N, and Kshirsagar P G, "A Textbook of Engineering Physics", S. Chand and Company Ltd, 2018.
2. Bhattacharya D.K. and Poonam T, "Engineering Physics", Oxford University Press, 2015.
3. Robert Eisberg, Robert Resnick Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Edition Paperback - 2006

REFERENCES

1. Halliday, D., Resnick, R. and Walker, J. "Principles of Physics". Wiley, 2020.
2. J. Griffiths David "Introduction to Quantum Mechanics" Paperback. 2015
3. Richard W. Robinett "Quantum Mechanics: Classical results, modern systems, and visualized examples" 2018
4. Donald A. McQuarrie, "Quantum Chemistry" 2016

WEB REFERENCES

1. https://nptel.ac.in/courses/122106034/
2. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/lecture-videos/
3. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/122105023/lec33.pdf

ENLIGHTENMENT THROUGH EDUCATION SREC

PREREQUISITE:

20PH204 Applied Sciences I

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Utilize the concepts of ferromagnetic materials in magneto rheological and electro rheological fluids.	PO1, PO5
CO2:	Extend the importance of photo chromic, photo thermo refractive and metallic glasses for industrial applications.	PO1
CO3:	Relate the different types of ceramic and dielectric materials along with their applications.	PO1, PO5
CO4:	Outline preparation of nanomaterials and significance of smart materials for technological applications.	PO1

MAGNETO AND ELECTRORHEOLOGICAL FLUIDS **8**

Magnetorheological Fluids :Introduction- Theory- Properties- Applications - Magnetostrictive Materials - Introduction- Origin - Linear Magneticstriction - Saturation Magneticstriction - Villari -Wiedemann - Magneto Volume Effects-Applications.

Electrorheological Fluids: Introduction- Theory- Properties - Characteristics - Giant Electro rheological Fluids - Giant Electro rheological based micro fluidics - Applications.

PHOTO CHROMIC AND PHOTOTHERMO REFRACTIVE GLASSES **8**

Introduction - Physical principles of photosensitivity in glasses - Induced coloration of reversible Photo chromic glasses - Heterogeneous photo chromic -Photo thermo refractive glasses - Applications.

MAGNETIC AND DIELECTRIC MATERIALS **6**

Ferromagnetism - domain theory - types of energy - hysteresis - hard and soft magnetic materials - ferrites - dielectric materials - types of polarization - Langevin-Debye equation - frequency effects on polarization - dielectric breakdown - insulating materials - Ferroelectric materials

SMART AND NANO MATERIALS **8**

Ceramics - types and applications - composites: classification - role of matrix and reinforcement - processing of fiber reinforced plastics - metallic glasses: types - glass forming ability of alloys - melt spinning process - applications Shape memory alloys - phases, shape memory effect - pseudoelastic effect - NiTi alloy applications - Smart materials - Actuator and actuator materials - Piezoelectric and Electrostrictive material.

Nanomaterials: preparation - Ball milling - MBE techniques - properties and applications.

Total Hours: 30

TEXT BOOKS

1. William D.Callister Jr, David G. Rethwisch "Materials Science and Engineering - An Introduction", Wiley India (P) Ltd., 8th Edition, 2018.

2. He Tian and Junji, "Zhang Photo chromic Materials: Preparation properties and Applications", 1st Edition, Wiley -VCH Verlag Gmbh and Co,KGaA , 2016.

REFERENCES

1. Raghavan, V. "Materials Science and Engineering : A First course". PHI Learning, 2015.
2. N.M. Wereley, "Magnetorheology: Advances and Applications", Royal Society of Chemistry, RSC Smart Materials, Cambridge, UK., 2014
3. Balasubramaniam, R. Callister, "Materials Science and Engineering", Wiley India Pvt. Ltd., 2014.
4. Rajput R.K., A Text book of Material Science and Engineering, S.K Kataria & sons, Delhi, 2003
5. Brain Culshaw, "Smart Structure and Materials", Artech House, 2nd Edition, 2004.
6. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/118104008/
2. https://nptel.ac.in/courses/112104251/
3. https://nptel.ac.in/courses/115105099
5. https://nptel.ac.in/courses/115106061
6. https://nptel.ac.in/content/storage2/courses/112104040/pdf/lecture36.pdf

ENLIGHTENMENT THROUGH EDUCATION SREC

20PH213 AIRCRAFT MATERIALS AND PROCESSES 2 0 0 2

PREREQUISITE:

20PH202 -Waves and Optics

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Label the various processes for any material used in a specific application.	PO1, PO2, PO12
CO2:	List the factors influencing the material's behaviour based on the environmental application.	PO1, PO2, PO12
CO3:	Interpret the various methods for enhancing the appropriate material's strength.	PO1, PO3, PO7, PO12
CO4:	Summarize the properties of metals and their alloys using the required standard procedures.	PO1, PO3, PO7, PO12

ELEMENTS AND PROPERTIES OF MATERIALS **6**

Structure of solid materials -atomic structure of materials -crystal structure -miller indices -density -packing factor -space lattices -X-ray diffraction -imperfections in crystals -physical metallurgy -classification of engineering materials -properties of materials: atomic; chemical; physical; mechanical; magnetic; electrical; thermal; acoustical; optical; nanostructures

MECHANICAL BEHAVIOUR OF MATERIALS **6**

Elasticity -plasticity -yielding and yield strength: tensile; compression; ductility -creep -fatigue -fracture -bauchinger's effect -notch effect -destructive testing using ASTM standards: tension; compression; flexural; hardness; impact; hydrostatic; crushing; torsion; wear; fatigue -non-destructive testing (NDT)

OXIDATION AND CORROSION **4**

Oxidation -pilling-bedworth ratio -kinetic laws of oxidation -types of corrosion -effect of corrosion on mechanical properties -methods of combat corrosion -corrosion resistance materials used for space vehicles

STRENGTHENING MECHANISMS AND HEAT RESISTANT MATERIALS **8**

Heat treatment processes: annealing; normalizing; quenching; hardening; work hardening; recovery and recrystallization; tempering; austempering; martempering; surface hardening -solid solution strengthening -precipitation hardening -grain boundary strengthening -single crystal solidification -grain sizing -alloying: numerical coding; effect of alloying elements; metal alloys (carbon steels; aluminium; copper; magnesium; titanium) -shape memory alloys -superalloys: Iron base; nickel base; cobalt base

SELECTION OF MATERIALS **6**

General requirements of materials for aerospace applications -case study on specific material applications: propeller blades; propeller hubs; cowling; engine mount; engine controls; firewall; oil lines; fuel tanks; fuel lines; hydraulic systems; landing gear; fuselage; wings; ailerons and flaps; instrument boards; seats; flooring; tail surfaces; windshield; bolts; rivets; springs

Total Hours: 30

TEXT BOOK

1. Titterton.G., "Aircraft Materials and Processes", 5th Edition, Himalayan Books, Indian Reprint., 2015.

REFERENCES

1. J.F. Shackelford J.F., Introduction to Materials Science for Engineers, 8th Edition, Pearson Prentice-Hall, Upper Saddle River, NJ, 2015.
2. Martin, J.W., "Materials for Engineering", 3rd Edition, Woodhead Publishing Ltd., 2006.
3. Van Vlack. L.H., "Element of Materials Science and Engineering", 6th Edition, Pearson Education India, 2002.

WEB REFERENCES

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://nptel.ac.in/courses/113/107/113107078/
3. https://nptel.ac.in/courses/113/104/113104081/
4. https://nptel.ac.in/courses/113/104/113104082/

ENLIGHTENMENT THROUGH EDUCATION SREC

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Experiment with laser to find the particle size of the lycopodium powder	POI, PO9
CO2:	Make use of ultrasonic waves to evaluate the acoustical parameters	PO1, PO5, PO9
CO3:	Apply Poiseuille's method to determine the viscosity of low viscous liquids.	PO1, PO9
CO4:	Utilise the appropriate method to find the young's modulus of the given material	PO1, PO9
CO5:	Examine the efficiency of the solar cell and acceptance angle of the optical fiber using suitable experimental set up	PO1, PO5, PO9
CO6:	Identify the thickness of thin film and wavelength of the mercury spectrum using the principle of interference and diffraction	PO1, PO5, PO9
CO7:	Make use of XRD to determine the lattice parameters of crystalline materials and sputtering unit of the deposited thin film	PO1, PO5, PO9
CO8:	Make use of electrochemical workstation to study the corrosion parameters and chemical route to synthesise a biomaterial and comprehend for suitable biomedical applications	PO1, PO5, PO9
CO9:	Develop effective communication skills through reports.	PO1, PO10

LIST OF EXPERIMENTS

1. Determination of Particle size of the given powder using He-Ne laser and demonstration of particle size analyzer.
2. Determine the velocity of the Ultrasonic waves in the given liquid medium and acoustic impedance using ultrasonic interferometer.
3. Determination of Co-efficient of Viscosity of the given liquid by Poiseuille's method.
4. Determination of Young's Modulus of the given material of the rectangular bar using cantilever method.
5. Estimation of Acceptance angle and Numerical Aperture (NA) of the Optical fiber.
6. Determination of Efficiency of a silicon cell (solar cell) and to study its characteristics.
7. Determination of wavelength of Mercury spectrum using diffraction grating.
8. Determination of thickness of a thin film - Air Wedge method
9. Demonstration of thin film deposition technique using Sputtering Unit.
10. Determination of lattice parameters of crystalline materials - XRD pattern.
11. Synthesise of a biomaterial using chemical route for biomedical application.
12. Demonstration of the corrosion parameters using electrochemical workstation.

20MA221 OPTIMIZATION TECHNIQUES 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Formulate and solve real life situations involving linear variables.	PO1,PO2,PO5,PO9
CO2:	Optimize the non-linear function subject to the constraints.	PO1, PO2, PO5, PO9
CO3:	Use search methods to find the optimum value of multivariable functions.	PO1, PO2, PO5, PO9
CO4:	Apply the decision making process in real life situations	PO1, PO2, PO5, PO9
CO5	Analyze the basic characteristic features in queuing models.	PO1, PO2, PO5, PO9

LINEAR MODELS **16**

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP-Simplex Method-Artificial Variable Techniques-BigM method.

NON LINEAR PROGRAMMING **8**

Unconstrained problems - necessary and sufficient conditions - constrained problems- equality constraints-inequality constraints-Kuhn-Tucker conditions.

CONVEX OPTIMIZATION **12**

Random search method - Univariate method - Gradient of a function -Cauchy's Steepest Descent Method - Conjugate gradient method.

DECISION ANALYSIS **8**

Introduction-Decision making problem-Decision making under certainty-Decision under uncertainty -Decisions under risk

QUEUING MODELS **16**

Introduction, Queuing Theory, Operating characteristics of a Queuing system, Constituents of a Queuing system, Service facility, Queue discipline, Single channel models :(M/M/1): (FIFO/?), (M/M/1): (FIFO/N), multiple service channel models: (M/M/C):(FIFO/?),((M/M/C):(FIFO/N).

Total Periods: 60

TEXT BOOKS

1. TahaH.A.,"Operations Research",8thEdition,Prentice Hall of India,2011.
2. KantiSwarup, Gupta P.K. and Manmohan, "Operations Research", Sultan Chand & Sons, 2010.
3. Veerarajan., T., "Probability, Statistics and Queuing Theory", Tata McGraw-Hill, Second Edition, New Delhi, 2016.

REFERENCE BOOKS

1. Fredrick S. Hillier and Gerald J. Liebermann, "Introduction to Operations Research", 8thEdition, McGraw Hill, 2011.
2. Anderson,"Quantitative Methods for Business", 10th Edition, Thomson Learning,2009.
3. Sharma J.K., "Operations Research Theory and Applications", 3rd Edition, Business Books, 2006.
4. Kalyanmoy Deb, "Optimization for Engineering: Design-Algorithms and Examples", PHI,Second edition, 2012.

WEB REFERENCES

1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ma29\
2. https://nptel.ac.in/courses/112/106/112106064/
3. https://nptel.ac.in/courses/111/105/111105100/

20MA101 **GRAPH THEORY** **2 1 0 3**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the basic concepts of graph theory and compute the distance in graphs and weighted graph	PO1, PO2, PO5, PO9
CO2:	Use the fundamental theorems in Graph theory to study matching, connectivity, coloring and planar graphs.	PO1, PO2, PO5, PO9
CO3:	Analyze matching problems.	PO1, PO2, PO5, PO9
CO4:	Apply graph model and algorithm for solving network problems.	PO1, PO2, PO5, PO9

FUNDAMENTALS OF GRAPHS AND TREES **10+5**

Graphs - Introduction - Isomorphism - Sub graphs - Walks - Paths - Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits. Trees - Distance and centers in tree - Rooted and binary trees - Spanning trees - Spanning trees in a weighted graph.

PLANAR, DUAL GRAPHS AND MATRIX REPRESENTATION OF GRAPHS **10+5**

Planar and dual graphs - Combinatorial representation- Detection of planarity - Geometric dual graphs. Incidence matrix - Sub matrices - Circuit matrix - Path matrix - Adjacency matrix. Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Vertex coloring - Edge coloring - Four color problem.

DIRECTED GRAPHS, GRAPH THEORETIC ALGORITHMS **10+5**

Digraphs - Types of digraphs - Directed paths and connectedness - Euler graphs - Adjacency matrix of a digraph. Algorithms - Connectedness and components - Spanning tree - Fundamental circuits - Cut vertices - Directed circuits - Shortest path algorithm.

Total Periods(30L+15T): 45

TEXT BOOKS

1. NarasingDeo, "Graph theory with application to Engineering and Computer Science", Prentice Hall India, 2016.
2. West D.B, "Introduction to Graph Theory", 2nd Edition, Prentice Hall, 2016.

REFERENCES

1. Harary F., "Graph Theory", Addison Wesley, 2019.
2. Wilson R.J., "Introduction to Graph Theory", 5th Edition, Pearson Education, 2010.

WEB REFERENCE

1. https://onlinecourses.nptel.ac.in/noc20_ma05/course

CASE STUDIES

1. Application of functional network organization in brain disorders.
2. Decision making in the Manufacturing Environment demonstrates.
3. Constructing agent's blackboard communication architecture based on graph theory.
4. Optimal PMUs placement and multiarea power system state estimation

MATLAB WEB REFERENCE

https://in.mathworks.com

ENLIGHTENMENT THROUGH EDUCATION
SREC

ENGINEERING SCIENCES (ES)

ENLIGHTENMENT THROUGH EDUCATION
SREC

20AE272 ENGINEERING DRAWING PRACTICES 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the standards of engineering drawing and representation of objects in multiple planes.	PO1
CO2:	Understand the concepts of orthographic projections of simple solids and sectioning of solids.	PO3
CO3:	Understand the concepts of pictorial representations of simple solids, prisms and pyramids.	PO5

ENGINEERING DRAWING

Introduction to Engineering Drawing - BIS Conventions and specifications - Size and Layout of drawing sheets - Lettering and Dimensions. ASME Standards - Y14. Representations of three dimensional Objects - Multiple views and their Placements. GD & T Symbols - Form, Location, Profile, Orientation, Run Out and Modifiers.

ORTHOGRAPHIC PROJECTIONS

General Principles - First angle projection - Projection of points - Projection of lines in first quadrant - Determination of true length - Projection of Polygonal Surface inclined to both planes - Projection of simple solids - sectioning of solids with cutting plane inclined to one plane. Development of Surface of simple and sectioned solids.

ISOMETRIC AND PERSPECTIVE PROJECTIONS

Principles of isometric projections - isometric scale - isometric projections of simple solids and truncated prisms and pyramids. Perspective projections of prisms and pyramids by vanishing point method.

Total Hours: 30

REFERENCES

1. G. Sreekanjana, K Venugopal,V Prabhu Raja, "Engineering Graphics", New Age International (P) Limited, 2011.
2. Gary Bertoline, Eric Wiebe, Nathan Hartman and William Ross, Technical Graphics Communication, 4th Edition, Kindle Edition.
3. Natarajan K. V, "Engineering Graphics", Dhanalaksmi Publications, 20th Edition, 2006.
4. Kirstie Plantenberg, "Engineering Graphics Essentials", SDC Publications, 5th Edition, 2016.

20AE204 FLUID MECHANICS AND MACHINERY 2 1 0 3

COURSE OUTCOMES

PREREQUISITE:

1. 20MA202-Matrices, Differential Calculus and Transforms
2. 20MA205-Calculus and Numerical Methods

On successful completion of the course, students will be able to

CO1:	Explain the physical properties of fluids at rest and at motion	PO1, PO2
CO2:	Model mathematical equations of fluid principles	PO2, PO3
CO3:	Describe the types of fluid flow and governing equations of fluid flow	PO1, PO2
CO4:	Summarize the losses in the fluid flow	PO3, PO
CO5:	Classify the fluid machines	PO2
CO6:	Illustrate the velocity triangle	PO3

FLUID STATICS **12**

Types of substances and their significance - Units and dimensions - Properties of fluids - Density, Specific weight, Specific volume, Specific gravity, Temperature, Viscosity, Compressibility, Vapor pressure, Capillary and Surface tension - Concept of fluid static pressure, absolute and gauge pressures - Pressure measurements by manometers

FLUID DYNAMICS **13**

Types of flow -Velocity field and acceleration - Lines of flow - Equation of streamline - Stream function - Velocity potential function - Continuity equation - Equations of motion - Euler's equation along a streamline - Bernoulli's equation - Applications -Venturi meter, Orifice meter, Pitot tube

VISCOUS FLOW **13**

Laminar flow between parallel plates - laminar flow through circular tubes (Hage Poiseuille's Equation) - Flow through pipes (Darcy Weishback equation) - Chezy's Formula - Minor Losses and Major losses - Moody diagram

FLUID MACHINES **7**

Principle of Operation - Classification Based on Energy Conservation - Classification Based on Principle of Operation - Blade velocity triangle

Total Periods: 45

TEXT BOOK

1. Frank M.White, "Fluid Mechanics", 8th Edition, Mc Graw Hill Publications, 2015
2. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2004

REFERENCES

1. K.L.Kumar, "Engineering Fluid Mechanics", 8th Reprint Edition, S.Chand & Co., 2014.
2. Cohen Kundu, P. K., Cohen, I. M., and Dowling, D. R., "Fluid Mechanics", 5th Edition, Academic Press, 2012

WEB REFERENCES

1. NPTEL Course: nptel.ac.in/courses/112105183/.
2. NPTEL Course: http://www.nptelvideos.in/2012/11/fluid-mechanics.html

20AE205 **THERMODYNAMICS** **2 1 0 3**

PREREQUISITE:

20PH202-Waves and Optics

20CH202-Chemical Science

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Discuss basic concepts and the applications relevant to first law of thermodynamics	PO1, PO2
CO2:	Describe second law of thermodynamics, entropy and availability concepts	PO1, PO2
CO3:	Illustrate and compare different air cycles	PO1, PO2, PO3, PO5
CO4:	Interpret the fuel combustion thermodynamics	PO1, PO2
CO5:	Explain steam properties and air compressor	PO3, PO4, PO5

BASIC CONCEPTS AND FIRST LAW **9**

Concept of continuum, macroscopic approach, and thermodynamic systems - Property, state, path and process-quasi-static process - work, Zeroth law of thermodynamics - Concept of temperature and heat, internal energy, specific heat capacities, enthalpy - Concept of ideal and real gases - First law of thermodynamics and its applications to closed and open systems - Introduction to heat transfer - Numerical problems

SECOND LAW AND ENTROPY **9**

Second law of thermodynamics - Kelvin Planck and Clausius statements of second law - Reversibility and irreversibility - Carnot theorem - Carnot cycle, Reversed Carnot cycle, Efficiency-Introduction refrigeration cycle - Thermodynamic temperature scale - Clausius inequality, concept of entropy, entropy of ideal gas - principle of increase of entropy-Numerical problems

AIRCYCLES **9**

Otto, Diesel, Dual and Brayton cycles -Air standard efficiency - Mean effective pressure. Comparison of Otto, Diesel and Dual cycle, introduction to modified Brayton cycle and Jet Propulsion cycle -Numerical problems

COMBUSTION THERMODYNAMICS **9**

Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy of combustion

STEAM PROPERTIES AND COMPRESSORS **9**

Properties of steam - Rankine cycle - Classification and working principle of compressors-Work of compression with and without clearance -Isothermal and Isentropic efficiency of reciprocating air compressors multistage compression and intercooling -Various types of compressors

Total Periods: 45

TEXT BOOK

1. Cengel, Y. A. and Boles, M. A., Thermodynamics: An Engineering Approach, 8th ed.,McGraw-Hill, 2014
2. Nag, P. K., Engineering Thermodynamics, 5th edition. Tata McGraw-Hill, 2013

REFERENCES

1. Moran, M. J., Shapiro, H. N., Boettner, D. D., and Bailey, M. B., Principles of Engineering
2. Thermodynamics (SI Version), 8th ed., Wiley, 2015
3. D. P. Mishra, Fundamentals of Combustion, PHI Learning Pvt. Ltd. Revised 1st edition, 2007
4. Borgnakke, C. and Sonntag, R. E., Fundamentals of Thermodynamics, 8th ed., Wiley, 2013
5. Balmer, R. T., Modern Engineering Thermodynamics, Academic Press, 2011

WEB REFERENCES

1. NPTEL Course: http://nptel.ac.in/courses/101104063/
2. https://www.edx.org/learn/thermodynamics
3. https://www.coursera.org/learn/thermodynamics-intro
4. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/index.html

ENLIGHTENMENT THROUGH EDUCATION SREC

20AE273 MECHANICAL SCIENCES LABORATORY 0 0 2 1

PREREQUISITE:

20PH213-Aircraft Materials and Processes

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Demonstrate the basic experiments on fluid mechanics to estimate the fluid properties	PO1, PO2
CO2:	Describe the basic experiments on Mechanics of Materials to determine the mechanical properties	PO1, PO2, PO3
CO3:	Perform the basic experiments on Thermodynamics to calculate the thermal properties	PO1, PO2, PO3
CO4:	Communicate the experimental results through reports	PO9, PO10, PO12

LIST OF EXPERIMENTS

FLUID MECHANICS

1. Determination of Coefficient of discharge of Venturi meter
2. Determination of Coefficient of discharge of Orifice meter
3. Determination of friction factor for flow through pipes
4. Experiments on flow losses in pipes

STRENGTH OF MATERIALS

5. Determination of centre of gravity and Moment of Inertia of lamina
6. Experiment on Plane truss and Friction
7. Tension and compression test on mild steel.
8. Brinell and Rockwell Hardness tests
9. Izod and Charpy Impact tests
10. Determination of Tension and Compression strength on helical springs

THERMODYNAMICS

11. Plot the valve and port timing diagram
12. Determination of brake thermal efficiency of a 4 stroke engine

Total Periods: 15

20BM202 FRONTIERS IN BIOMEDICAL ENGINEERING 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Comprehend the recent advancements in the fields of biomedical computing, biomechanics, tissue engineering.	PO1, PO7
CO2:	Summarize the knowledge about the various career opportunities in the fields of biomedical engineering.	PO1, PO7

PERSPECTIVES IN BIOMEDICAL ENGINEERING **6**

Evolution of the modern health care system - Introduction to biomedical engineering - Role of biomedical engineers -Major players in biomedical engineering equipments - OEM. Professional status of biomedical engineering - Professional Societies.

DISCIPLINES OF BIOMEDICAL ENGINEERING **6**

Clinical engineering, Diagnostics and therapeutic equipments, Medical signal, image processing and analysis, wearable medical devices, Biomechanics and rehabilitation engineering, Tissue engineering, Lab-on-a-chip, point of care diagnostic devices, precision health care technology. Clinical genomics, proteomics, pharmacogenomics, stem cell technology, nanomedicine, 3D printing and bioprinting technology.

NEXT GEN HEALTHCARE TECHNOLOGIES **10**

Novel technologies with impact in the medical device industry. Advances in medical imaging systems and PACS, Healthcare digital transformations, Internet of Things in medicine, virtual reality, artificial intelligence and medical applications, predictive health - big data and analytics, precision medicine, mobile applications for health care, Chatbots in healthcare, microsystem technologies, medical robotics,drones.

ACTIVITIES (any three) **8**

- Visit hospitals/ rehabilitation centres/ geriatric care centres/ diagnostic laboratories/ start-ups and submit a report on the scope of engineering healthcare in the relevant sectors.
- Interview an entrepreneur and make a presentation.
- Do a product survey surfing the websites of top 10 biomedical companies in each domain and presentation
- Prepare review on scope of research and challenges in biomedical engineering

Total Hours: 30

TEXT BOOKS

1. Joseph D. Bronzino, Donald R. Peterson, "The Biomedical Engineering Handbook", 4th edition, CRC Press, 2015.
2. Arthur B. Ritter, Vikki Hazelwood, Antonio Valdevit, Alfred N. Ascione. "Biomedical Engineering Principles", 2nd Edition, CRC Press, 2011.
3. Ewaryst Tkacz, Marek Gzik, Zbigniew Paszenda, Ewa Pitka, Innovations in Biomedical Engineering, Springer International Publishing, 2019.

REFERENCES

1. www.embs.org
2. www.bmes.org
3. www.tissue engineering international & regenerative medicine society.org

20BM204 **CIRCUITS AND DEVICES** **3 1 0 4**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Determine the current and voltage by applying laws and network theorems.	PO1
CO2:	Use reduction techniques and Wye delta transformations to reduce complex circuits into simple circuits	PO1
CO3:	Analyze mesh and nodes to compute the current and voltage magnitudes in different branches of the given circuit.	PO1
CO4:	Compute impedance, admittance and obtain the transient, frequency response of series and parallel circuits.	PO1
CO5:	Explain the operation, characteristics and applications of semiconductor devices.	PO1
CO6:	Explain the characteristics of operational amplifiers and its applications.	PO1

DC AND AC CIRCUIT ANALYSYS **10**

Concepts of circuits, basic laws - Ohm's Law and Kirchhoff's laws - Resistors topology, voltage and current division, Wye-Delta transformations, applications - Circuit analysis fundamentals, nodal analysis, mesh analysis capacitor, inductors, sinusoids and phasors; real power-reactive power, complex power, apparent power impedance and admittance RC/RL circuits.

NETWORK THEOREMS **12**

Thevenin's theorem, Norton's theorem, superposition and power transfer theorems for DC and AC circuits.

TRANSIENT AND RESONANCE CIRCUITS **6**

Step and sinusoidal response of series RLC circuits, frequency response of series and parallel RLC circuits, resonance of RLC circuits.

DEVICE CHARACTERISTICS **12**

Semiconductor Theory - Energy Band theory - Charge densities in semiconductors - Mobility and Conductivity - Drift and Diffusion current. Diodes - Characteristics and applications BJT: Characteristics and h-parameters - Biasing circuits and types - Transistor as a switch - Transistor amplifier circuits- Characteristics and applications of JFET and MOSFET.

OPERATIONAL AMPLIFIERS **5**

Operational amplifiers - fundamentals and applications.

Total Hours: 60(45L+15T)

TEXT BOOKS

1. Robert. L.Boylestad, Louis Nashalskey, "Electronic Devices and Circuits", 11th Edition, Pearson Education, India, 2015.
2. Jacob Millman, Christos C Halkias, Satyabrata Jit "Electronic Devices and Circuits", 4th Edition, Tata McGraw Hill,2015.

3. Ramakant A Gayakwad, "Op - Amps and Linear Integrated Circuits", PHI Learning Private Limited, 4th edition, 2009.

REFERENCES

1. William H.Hayt, Jack E.Kemmerly and Steven M.Durbin, "Engineering Circuit Analysis", 8th Edition,Tata McGraw-Hill Education, 2013.
2. Thomas L Floyd, "Electronic devices conventional current version", 10th Edition, Pearson Education, India, 2017.
3. Charles. K. Alexander, Mathew.N.O.Sadiku, "Fundamentals of Electric Circuits", 6th Edition, Tata McGraw Hill Education,2016.
4. Joseph A.Edminister,mahmood Nahvi,"Electric circuits -schaum's series,7th edition,McGraw Hill Education Private Limited ,Newdelhi 2017.
5. William H.Hayt,Jack.E.Kemmerly and steven M Durbin, "Engineering circuit analysis"9th edition, McGraw Hill Education Private Limited ,Newdelhi 2018.

ENLIGHTENMENT THROUGH EDUCATION SREC

20BM272 CIRCUITS AND DEVICES LABORATORY 0 0 2 1

Course Outcomes:

At the end of the course, the student should be able to

CO1:	Verify Ohm's law, Kirchhoff's law and network theorems	PO1
CO2:	Draw the characteristics of series and parallel resonance circuits.	PO1
CO3:	Describe the characteristics of basic electronic devices, current and voltage - controlled devices.	PO1
CO4:	To verify the characteristics of circuits using simulation tools.	PO1

LIST OF EXPERIMENTS

1. Verification of Ohm's law, Kirchhoff's law.
2. Verification of Network theorems.
3. Frequency response of series resonance and parallel resonance circuits.
4. PN Junction Diode Characteristics and applications
5. Zener Diode Characteristics and applications.
6. FET Characteristics.
7. Design and analysis of simple circuits using simulation tools.

ENLIGHTENMENT THROUGH EDUCATION SREC

20BM213 PRINCIPLES OF TELEMEDICINE AND MOBILE APPLICATIONS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Explain the basic principles of healthcare in Telemedicine.	PO5, PO6
CO2:	Understand the concepts of technology, security and standards kin Telemedicine	PO5, PO6
CO3:	Understand the applications of healthcare telemedicine	PO5, PO6
CO4:	Explain mobile app development for health care applications.	PO1, PO5, PO6

INTRODUCTION OF TELEMEDICINE **9**

History and Evolution of Telemedicine, Functional diagram of Telemedicine system, Essential Parameters for Telemedicine, Delivery Modes in Telemedicine, Benefits and Limitations of Telemedicine.

TELEMEDICAL TECHNOLOGY, SECURITY AND STANDARDS **12**

Principles of Multimedia - Text, Audio, Video, Data, PSTN, POTS, ANT, ISDN, Internet, Wireless Communication - GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Satellite communication, Mobile hand-held devices and Mobile communication. Internet technology and telemedicine using worldwide, Video and audio conferencing. Encryption, Cryptography, Mechanisms of encryption, Phases of Encryption, Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN)

MOBILE TELEMEDICINE **12**

Tele radiology: Definition, Basic parts of teleradiology system: Image Acquisition system Display system, Tele pathology, Multimedia databases, Color images of sufficient resolution, Dynamic range, spatial resolution, Compression methods, Interactive control of color, Medical information storage and management for telemedicine, Patient information medical history, Test reports, Medical images diagnosis and treatment. Hospital information system, Doctors, paramedics, facilities available. Pharmaceutical information system. Telemedicine and monitoring of physiological parameters (telehealth) - telesurgery

MOBILE APPLICATION DEVELOPMENT **12**

Mobile devices - architecture, operating systems. Mobile application design - user interface design - storage and retrieval of data, Augmented reality, Integrating with networks and cloud services. Hardware integration. Mobile device testing and protection. Interfacing diagnostics with consumer electronics, Translating Sensor Technology into the Medical Device Environment. Case studies - Lab on a chip/mobile phone and acute care blood testing, Automated Blood Smear Analysis for Mobile Malaria Diagnosis, cervical screening by Automated Image cytometry, Phone Oximeter, Wireless Smart Polysomnograph. Portable High-Frequency Ultrasound Imaging System Design and Hardware considerations.

Total hours:45

TEXT BOOKS

1. Norris, A.C, "Essentials of Telemedicine and Telecare", John Wiley and sons, 2016.
2. Bernard Fong, A.C.M. Fong, C.K. Li, "Telemedicine Technologies: Information Technologies in Medicine and Tele health", Wiley, 2020.

REFERENCES:

1. Wootton, R., Craig, J, Patterson, V (Eds.). "Introduction to Tele medicine (2nd Ed.) London: Royal Society of Medicine Press Ltd". 2017.
2. Walter Karlen, "Mobile point of care Monitors and Diagnostic Device Design", CRC Press, 2020.

20CE203 CONSTRUCTION MATERIALS, TECHNIQUES AND EQUIPMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Restate the types of materials involved in construction based on NBC Guidelines.	PO1
CO2:	Summarize the various process and services followed during construction of buildings with modern techniques.	PO1, PO5
CO3:	Examine the utilization of Vertical Transportation and Equipment based on its features.	PO1,PO8

CONSTRUCTION MATERIALS **8**

Brick: Manufacturing- Properties - Classification and Tests. Stones: Quarrying - Dressing and Properties. Cement: Manufacturing - Properties - Types and Tests. Steel: Manufacturing - Types - Properties. Wood Joineries - Advanced Civil Engineering Materials-NBC Guidelines.

CONSTRUCTION PRACTICES **9**

Substructure: Site Clearance - Marking - Earthwork - Foundation: Shallow Foundation - Deep foundation

Superstructure: Brick masonry - Stonemasonry -Flooring - Roofing - Advanced techniques using Robotic Machines.

BUILDINGSERVICES **8**

Whitewashing - Distempering - Painting - Wall putting - Fire Protection, Acoustics and Sound insulation as per NBC - Damp proofing- Termite proofing - Sensor based building construction and services.

VERTICAL TRANSPORTATION **10**

Staircases - Types - Staircase planning and geometric rules -Construction practice- Lift: Types - basic Components - Lift well construction - Safety rules as per NBC- Escalators and walk ways - Basic concept and Construction practice. Lift with and without head room - Ramps.

CONSTRUCTION EQUIPMENT **10**

Selection of equipment for Earthwork - Earthmoving operations - Foundation and pile driving - Compaction - Batching - mixing and concreting - Material handling and erection of structures - Dredging - Trenching and Tunneling - Tower crane.

Total Hours: 45

TEXT BOOKS

1. Clifford J.Schexnayder, Robert L. Peurifoy, Robert Schmitt and Aviad Shapira.," Construction Planning, Equipment and Methods ", 9th Edition, McGraw Hill, 2018.
2. Arora S P and Bindra S P., "A text book of Building Construction", 5th Edition, Dhanpat Rai Publications, 2010.
3. National Building Code 2016.

REFERENCES

1. Punmia B.C, Ashok Kumar Jain and Arun Kumar Jain., "Building Construction", 11th Edition ,Laxmi Publications Pvt. Ltd., 2016.
2. Gurcharn Singh., "Building Construction and Materials", 17th Edition, Standard Book House, 2019.

WEB REFERENCES:

1. https://nptel.ac.in/courses/105102088/#
2. https://nptel.ac.in/courses/105/106/105106053/

20CE204 GEODESY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Summarize the basic concepts of traditional and geodesy surveying.	PO1
CO2:	Interpret the measurement and working principles of different types of surveying related with field conditions.	PO1
CO3:	Examine the advancement of digital and engineering surveying measurements.	PO1, PO2, PO5

OVERVIEW OF SURVEYING AND LEVELLING **9**

Definition - Principles -Types &Classification - Well-conditioned triangles - Errors - Corrections - Obstacles in surveying - Levelling - Bench marks - Fly and Check levelling - Booking - Reduction - Curvature and Refraction - Reciprocal levelling - Longitudinal and cross sections -Plotting - Calculation of areas and volumes - Contouring - Methods - Characteristics and uses of contours.

GEODESY **9**

Definitions- Classifications, Problem of Geodesy and purpose of Geodesy-Reference Surfaces and their relationship. Applications - Engineering, Lunar and Planetary Geodesy- Interferometric Synthetic aperture radar Geodesy - Local and International Spheroid.

THEODOLITE AND TACHEOMETRIC SURVEYING **9**

Theodolite - Description and uses - Temporary and permanent adjustments of Vernier transit - Measurement of horizontal and Vertical angles - Heights and Distances - Traversing - Closing error and distribution - Tangential, stadia and subtense methods.

DIGITAL SURVEYING **9**

Methods of Measuring Distance- Basic Principles of Total Station - Classifications- applications and comparison with conventional surveying - Microwave system- Measuring principle- working principle- Sources of Error -Care and maintenance of Total Station instruments- Traversing and Trilateration. Introduction- GPS - Different segments: Space- control and user segments - Uses- Photogrammetric surveying techniques.

ENGINEERING SURVEYING **9**

Hydrographic Surveying - Methods - Applications and Uses - Preliminary works - Reconnaissance - Locate Horizontal Control - Locate vertical Control - Sounding - Equipment. Highway survey - Different types of survey - Map Study- Reconnaissance-Preliminary survey- Location Survey-Engineering Surveys for Highway -Traffic surveys - Soil and material surveys - Drainage surveys -Topographic surveys - astronomical Surveying - Field observations and determination of time, longitude, latitude and azimuth by altitude.

Total Hours: 45

TEXT BOOKS

1. Punmia B.C., "Surveying ", Vol. I and II, Laxmi Publications Pvt. Ltd, 2011
2. Guy Bomford, "Geodesy" Nabu Press, 2010

REFERENCES

1. Duggal S.K., "Surveying", Vol. I and II, 3rd Edition, Tata McGraw Hill Education Pvt. Ltd, 2009.
2. Torge, Wolfgang / Müller, Jürgen, "Geodesy", ISBN 978-3-11-025000-8, Professional Book, 2012.
3. Amazon's J. Paul Guyer, "introduction to hydrographic survey", ISBN-13: 978-1730736001 independently published, 2018.
4. Osama Ragab "Steps of Highway Survey" DOI: 10.13140/RG.2.1.3583.2088.

WEB REFERENCES:

1. https://nptel.ac.in/courses/105107122/
2. https://nptel.ac.in/courses/105/104/105104101/
3. https://nptel.ac.in/courses/105/107/105107157/
4. https://nptel.ac.in/courses/105101087/

ENLIGHTENMENT THROUGH EDUCATION SREC

20CE205 ENGINEERING MECHANICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Recite the components of forces and resultant of a system of forces.	PO1, PO2
CO2:	Determine the support reactions and internal forces in determinate structures.	PO1, PO2
CO3:	Calculate the frictional forces and moment of inertia of laminas	PO1, PO2
CO4:	Examine the characteristics of kinematics and the equation of motion to Kinetics of particles.	PO1, PO2

STATICS

BASICS AND STATICS OF PARTICLES **9**

Forces and their types - Resolution of forces - Resultant and Equilibrium of bodies due to coplanar and non - coplanar concurrent forces - Moment of forces - Equilibrium of rigid bodies due to non - concurrent forces - Equivalent forces and moments

EQUILIBRIUM OF RIGID BODIES **9**

Classifications of structures - Analysis of simple plane trusses - Beams: Types of Beams, Types of loads - Determination of support reactions - Analysis of Frames - Forces in Cables

FRICTION AND PROPERTY OF SURFACES **9**

Laws of friction-coefficient of friction-problems involving dry friction - wedge & ladder friction-Center of gravity of standard areas by integration method - Center of gravity and moment of inertia of laminas.

DYNAMICS **18**

KINEMATICS

Kinematics: Introduction - Types of motion - Motions with uniform velocity, uniform acceleration, acceleration withgravity - Projectiles.

KINETICS

Kinetics: Applications of Newton's second law of motion D'Alemberts principle, Work and Energy method - Motion of connected bodies - Impulse and momentum - Impact of elastic bodies.

Total Hours: 45

TEXT BOOKS

1. Bansal R.K., "Engineering Mechanics", Laxmi Publications (P) Ltd, 2018.
2. Kottiswaran N., "Engineering Mechanics", Balaji Publication (P) Ltd, 2018.

REFERENCES

1. Beer F.P and Johnson Jr. E.R., "Vector Mechanics for Engineers: Statics and Dynamics", Vol. 1 Statics and Vol. 2 Dynamics, McGraw - Hill International Edition, 2017.
2. J.L. Meriam, L.G. Karige, J.N. Bolton, "Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics (Volume II)", Wiley student edition, 8th edition 2017.
3. Rajasekaran S and Sankarasubramanian G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., 2013.

WEB REFERENCE

1. http://nptel.ac.in/courses/112103108/

20CE270 BUILDING PLANNING AND DRAFTING LABORATOR Y 1 0 2 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Illustrate the 2D drawings of load bearing and framed structures with Solar Architecture concepts.	PO1, PO5
CO2:	Develop the detailed2D drawing and 3D Modeling of building intended for local body approval.	PO1, PO5, PO9,PO10

PREREQUISITE: 20ME272 - Computer Aided Engineering Graphics Laboratory

LIST OF EXPERIMENTS

Fundamental commands of AutoCAD & modeling software to draft the building drawings

Building drawing in accordance with IS: 962- 1989 (Reaffirmed 2001) Code of practice for Architectural and Building drawing using Auto CAD and Sketch Up (2D&3D) Software

1. Study of Solar Architecture concepts for building plan
2. Setting out of Single Storey residential and Draw the joinery details: Truss, Door& windows
3. Detailed working drawing for load bearing structures and framed structures
4. Detailed working 2Ddrawing - Site plan, Foundation plan, Cross section, Elevation and Staircase plan - Two dimensions only.
   a) Residential building
   b) Commercial building
      (i) Office building (ii) Shopping complex
5. Pictorial View: Principles of Perspective view to draw 3D modeling
6. Plan of Electrical wiring and plumbing layout for residential building

TEXT BOOKS

1. Shah M.G, Kale C.M and Patki S.Y., "Building Drawing with an Integrated Approach to Built Environment", Tata McGraw Hill Publishers Limited, 7th Edition, 2019.
2. Verma B.P., "Civil Engineering Drawing", Khanna Publishers, 12th Edition, 2018.

WEB REFERENCE

1. http://nptel.ac.in/courses/112102101/nptel.aic/building drawing -intro.pdf

20CE271 GEODESY LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Apply the leveling surveying principles for graphical representation of ground undulations.	PO1, PO2, PO3, PO5, PO9
CO2:	Demonstrate the accessible and inaccessible points of linear and vertical measurements.	PO1, PO2, PO3, PO5,PO9
CO3:	Create/Develop/Formulate the Plan/route map for the given water bodie s/ land field using the optimum solution for Civil Engineering projects.	PO1, PO2, PO3, PO5,PO9

LIST OF EXPERIMENTS

1. Interpret the Reduced Level for given points by rise & fall and Height of Collimation method.
2. Draw the Longitudinal Section and Cross Section for the given filed work.
3. Prepare Contouring map for the given area.
4. Measurement of horizontal angles between the points in the given area.
5. Demonstrate and calculate the distance between the points and elevation of the inaccessible points using all possibility methods in the field.
6. Measurement of distance between points by digital surveying.
7. Estimate the area of given polygon by advanced surveying.
8. Identify the longitude and latitude of location using modern tool in the surveying.
9. Study of Geodetic GPS
10. Study of drone survey and its applications.

ENRICHMENT THROUGH EDUCATION SREC

20CE272 MATERIAL TESTING LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Determine the Principles of testing toobserve the properties of Cement and Brick.	PO1, PO4
CO2:	Infer the specimen's stress-strain relationship, impact energy, hardness, tension, and compression strength.	PO1,PO4, PO5,PO10

LIST OF EXPERIMENTS

1. Determination of Properties of Cement

   Fineness - Standard consistency - Initial and Final setting time -Specific gravity -Soundness -Compressive strength-Stress monitoring using Sensor.

2. Determination of Properties of Brick:

   Compressive strength -Water absorption and Efflorescence test - Soundness -Hardness test

3. Plot the relationship between stress and strain on Tension test of mild steel.
4. Evaluation of Tension and Compression strength of springs.
5. Measure the impact energy of the Mild steel.
6. Hardness test

TEXT BOOKS

1. National Building Code 2016

WEB REFERENCES

1. https://nptel.ac.in/courses/112/107/112107146/

20CE219 SMART CITY AND URBAN PLANNING 2 0 0 2

PREREQUISITE

20CE202 Principles of Architecture and Planning Concepts

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Infer the fundamental concepts of Governance of smart cities policy	PO1
CO2:	Outline the characteristics of urban sustainability to adhere the technological advancement.	PO1
CO3:	Apply the principles of urban transport infrastructure design in the implementation of responsive smart cities.	PO1
CO4:	Justify the methodologies of urban E-planning for the smart building management system.	PO2,PO11

INTRODUCTION **6**

Definition- Understanding - Dimensions - Global experience- Global standards and performance benchmarks-, Practice codes- India smart cities policy and mission-Smart city planning and development- financing smart cities development-Governance of smart cities. Study area delineation - Zoning.

CITY AND METROPOLITAN PLANNING **6**

Growth trends- processes- characteristics- concepts- concerns of urban sustainability- diversity and unintended growth- economic- social- environmental sustainability- quality of life and equity- climate change- transit oriented development- participatory planning- Urban Transport planning

Inner city - issues and problems- Urban Development Policies.

SMART URBAN TRANSPORT SYSTEMS **6**

Resource analysis- Provision of infrastructure- Role of transport- types of transport systems- evolution of transport mode- transport challenges and mobility.

Urban form and Transport patterns- land use - transport cycle- concept of accessibility- Basic principles of Transport infrastructure design-Urban transport planning process -Principles and approaches of Traffic Management-Transport System Management.

MEASUREMENT OF URBAN SMARTNESS AND SUSTAINABILITY **6**

Spatial simulation- spatial statistical models-Space temporal modelling- collaborative mapping- Geo-tagging- Volunteered Geographic Information- ontologies for urban planning- City Geography Mark- up Language (GML) maps mash up- tangible maps and planning-smart public watering, timers and programmers complemented with weather forecast, humidity data.

Smart environment: Monitoring -Air quality - water quality- noise- humidity-temperature- sewage and solid waste management

URBAN PLANNING AND ICT **6**

New urbanism-Ruralism- fractal city- digital city- Smart City experiences in the new city and existing city.

Total Periods: 30

CASE STUDIES

1. Zero waste approach towards a sustainable waste management.
2. Network Visualization and Routing using QGIS.
3. Creation of smart city Maps with QGIS

TEXT BOOKS

1. Sameer Sharma, "Smart Cities Unbundled" Bloomsbury India2018
2. Amitabh Satyam , "The Smart City Transformations: The Revolution of The 21st Century" Bloomsbury India, 2017

REFERENCES

1. Dr.N.Mani, "Smart Cities & Urban Development in India" New Century Publications; 1st edition 2016
2. Andy Pike, Andres Rodriguez-Pose, John Tomaney, 'Handbook of Local and Regional Development', Taylor & Francis, 2010
3. Daniel G. Parolek, AIA, Karen Parolek, Paul C. Crawford, FAICP, Form Based Codes: A Guide for Planners, Urban Designers, Municipalities, and Developers, John Wiley & Sons, 2008.

WEB REFERENCES

1. https://nptel.ac.in/content/storage2/courses/109104047/pdf/lecture35.pdf

20CS201 DISRUPTIVE TECHNOLOGIES 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the emergence and impact of Disruptive Technologies in the current World	PO1, PO2
CO2:	Apply the innovative disruptive ideas to the dynamic problems of Industry 4.0.	PO2, PO3, PO4, PO12
CO3:	Analyze various Disruptive Technological trends with an emphasis to sustainability in the modern World.	PO2, PO3, PO4, PO7, PO12
CO4:	Examine the consequences of the modern disruptive processes while deploying with the traditional Industrial Practices.	PO2, PO3, PO4, PO12

INTRODUCTION **10**

Introduction - Technology trends - Overview of how technological disruption happens - Mega Trends Industry transformation - Fundamentals of Industry 4.0 - Addictive manufacturing - Disruptive Technology overview - Disruptive idea - Identifying opportunities and Technology - Insights into disruptive innovation.

MODERN DISRUPTIVE TECHNOLOGIES **20**

Introduction to IoT- Smart X Applications - Industrial IoT- Foundations of Data Science -New Trends in Data Science and Analytics - Artificial Intelligence for everyone: Applications of AI - Applications of Deep Learning and Machine Learning- Introduction to Cyber Security - Firewall - IDS and Digital forensics. Block Chain: Fundamentals and Use Cases. Defining UX and the process - Virtual Environment Standards and Terminology - Augment Reality / Virtual Reality - Human Computer Interaction: Foundations and its applications.

Total Hours:30

TEXT BOOKS

1. P. Armstrong. "Disruptive Technologies: Understand, Evaluate, Respond", Kogan Page Publishers. 2017.
2. John Paul Mueller, Luca Massaron, "Artificial Intelligence for Dummies", 1st Edition, Kindle, 2018
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and cryptocurrency technologies: a comprehensive introduction", Princeton University Press, 2016.
4. Lillian Pierson, "Data Science For Dummies", Kindle, 2nd Edition,2015
5. Qurban A Memon, Shakeel Ahmed Khoja, "Data Science: Theory, Analysis and Applications", CRC Press, 2019.

REFERENCES

1. Ovidiu Vermesan Peter Friess, "Internet of Things - From Research and Innovation to Market Deployment", River Publishers, 2014.
2. Roger Arrick, Nancy Stevenson, "Robot Building For Dummies", Wiley, 2011.
3. Denis Rothman, "Artificial Intelligence By Example", First Edition, O'Reilly, 2018.
4. By Kevin P. Nichols, Donald Chesnut, "UX for Dummies" Wiley, 2014
5. Kelly S. Hale, Kay M. Stanney "Handbook of Virtual Environments: Design, Implementation, and Applications", Second Edition (Human Factors and Ergonomics), 2014.
6. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004

WEB REFERENCE

1. https://www.coursera.org/lecture/impact-of-technology/disruptive-innovation-tzQqc

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Relate the basic programming constructs to C Programming.	-
CO2:	Demonstrate the basic problem solving skills with the help of design aspects such as Algorithms, Pseudo codes and Flowcharts.	PO1,PO2,PO3,PO12
CO3:	Apply programming concepts such as Control Structures, Arrays, Functions, Pointers and Structures to Real World problems or situations.	PO2,PO3,PO4,PO12
CO4:	Examine the programmed solutions for its correctness and completeness.	PO2,PO3,PO4,PO12

DATA TYPES IN C AND ITS MEMORY REPRESENTATION 6

Integer types - Floating point types - Interpretations - Sizes- Bits - How Bytes are broken up into Bits - Breaking up a Character's Decimal Value into its Underlying Bit Structure - Interpreting Data that Consists of more than One Byte - Little Endian vs. Big Endian - Representations of Negative Numbers - Conversion among data types - Global Layout of Memory Mapping - Storage Class Specifiers.

OPERATORS AND CONTROL STRUCTURES 5

Assignment operator - Comparison operators - Arithmetic operators - Truncation - Promotion - If statement - Conditional operator - Switch - While - For - Do-while - Break - Continue.

LINUX TOOL CHAINS 9

GNU tool chain - Exploring gcc and gdb - creation of Makefile for automation of execution - Valgrind - ctags - CScope.

ADVANCED DATA TYPES 10

Structure - Array - Pointers - ampersand operator (&) - NULL - C strings - typedef. Functions - void - value and reference parameters - const- How arrays and pointers interact - The [ ] and + operators with pointers - base address/offset arithmetic.

Total Hours45 (30(L)+15(T)) : 60

TEXT BOOKS

1. Herbert Schildt, "C: The Complete Reference" ,McGraw Hill Education; 4th Edition, 2017
2. Richard M. Reese, Shroff, "Understanding and Using C Pointers: Core Techniques for Memory Management", O'Reilly; 1st Edition, 2013.

REFERENCES

1. Brian W. Kernighan, Dennis M. Ritchie, "C Programming Language", 2nd Edition, Prentice Hall, 1988.
2. Peter A. Darnell, Philip E. Margolis, "C: A Software Engineering Approach", Springer-Verlag New York, 1996.
3. Brian Gough, Richard M. Stallman, "An Introduction to GCC- for the GNU Compilers gcc and g++", Network Theory Limited, 2004.

WEB REFERENCES

1. https://chortle.ccsu.edu/AssemblyTutorial/index.html
2. https://chortle.ccsu.edu/StructuredC/index.html
3. http://programmedlessons.org/CPuzzlesNew/CpuzzlesMain.html
4. https://sourceware.org/gdb/current/onlinedocs/gdb/
5. https://www.gnu.org/software/make/manual/make.pdf
6. http://valgrind.org/docs/manual/manual-core.html
7. https://courses.cs.washington.edu/courses/cse333/19au/resources/ctags_tutorial.html

20CS241 PROGRAMMING FOUNDATIONS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Relate the basic programming constructs to C Programming.	-
CO2:	Demonstrate the basic problem solving skills with the help of design aspects such as Algorithms, Pseudo codes and Flowcharts.	PO1, PO2, PO3
CO3:	Apply programming concepts such as Control Structures, Arrays, Functions, Pointers and Structures to Real World problems or situations.	PO2, PO3, PO4
CO4:	Examine the programmed solutions for its correctness and completeness.	PO2, PO3, PO4

FOUNDATIONAL CONSTRUCTS OF PROGRAMMING **8**

Pseudo code and flowcharts - Binary Number System Representation - Integer types, Floating point types, Interpretations, Sizes, Bits - How Bytes are Broken Up into Bits - Breaking Up a Character's Decimal Value into its Underlying Bit Structure - Interpreting Data that Consists of More than one Byte - Little Endian vs. Big Endian - Representations of Negative Numbers - Conversion among data types.

BASIC DATA TYPES AND CONTROL STRUCTURES **10**

Basic Data types - Modifiers - Qualifiers - Operators - If statement - Conditional Operator - Switch - While - For - Do-while - Break - Continue - Global Layout of Memory Mapping - Storage Class Specifiers.

ADVANCED DATA TYPES AND MODULARIZATION **12**

Structure - Arrays - Pointer - Ampersand operator (&) - NULL - C strings - Typedef. Functions - Void -Value and reference parameters - Const - How Arrays and Pointers interact - The [ ] and + operators with Pointers - Base address/offset arithmetic - File I/O - Command line arguments

Total Hours: 30

TEXT BOOKS

1. Herbert Schildt, "C: The Complete Reference", McGraw Hill Education; 4th Edition, 2017
2. Deitel H.M., and Deitel P.J., "C: How to Program", 8th Edition, Pearson Education, 2015.
3. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language", 2nd Edition, Pearson Education India, 2015.

REFERENCES

1. Peter A. Darnell, Philip E. Margolis, "C: A Software Engineering Approach", Springer-Verlag New York, 1996.
2. Bradley A.R., "Programming for Engineers", Springer, 2011
3. Brian Gough Foreword by Richard M. Stallman, "An Introduction to GCC- for the GNU Compilers gcc and g++", Network Theory Limited, 2004.

WEB REFERENCES

1. https://chortle.ccsu.edu/AssemblyTutorial/index.html
2. https://chortle.ccsu.edu/StructuredC/index.html
3. http://programmedlessons.org/CpuzzlesNew/CpuzzlesMain.html
4. https://sourceware.org/gdb/current/onlinedocs/gdb/
5. https://www.gnu.org/software/make/manual/make.pdf
6. https://gcc.gnu.org/onlinedocs/gcc-10.1.0/gcc.pdf

20CS242 ARTIFICIAL INTELLIGENCE 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the history and fundamental understanding of Artificial Intelligence (AI) and its applications such as Robotics.	PO1, PO2, PO3, PO12
CO2:	Select appropriate language constructs and solution models for various problems associated in Artificial Intelligence	PO2, PO3, PO4, PO12
CO3:	Apply the basic problem solving principles of AI in solutions for the broader category of Real World Applications	PO2, PO3, PO4, PO12
CO4:	Examine the searching, knowledge representation and reasoning strategies of AI in Intelligent Agents.	PO2, PO3, PO4, PO12

INTRODUCTION **7**

Introduction to Artificial Intelligence(AI), History of AI, Logic and Computation, Artificial Intelligence Languages, Multi Agent Systems, Case study: Google Duplex

SEARCH STRATEGIES AND PLANNING **8**

Problem spaces and search, Knowledge and rationality, Heuristic search strategies, Search and optimization (gradient descent), Adversarial search, Planning and scheduling, Case study: Scheduling

KNOWLEDGE REPRESENTATION AND REASONING **7**

Logic and inference, Ontologies, Bayesian Reasoning, Temporal reasoning, Knowledge, Case study: Medical diagnosis

ROBOTICS AND APPLICATIONS OF AI **8**

Introduction to Robotics, Effectors and Sensors, Case Study: Robotics in Entertainment.

Application: Artificial Intelligence in precision Health, Artificial Intelligence in Aviation Industry, Use cases of Artificial Intelligence in Agriculture, Artificial Intelligence for Faster Finance, Case study of Fully Autonomous vehicles, Future of Artificial Intelligence in Video Gaming.

Total Hours: 30

TEXT BOOKS

1. Stuart Russell and Peter Norvig, "Artifcial Intelligence: A Modern Approach", 3rd Edition, Pearson Education, 2010.
2. Denis Rothman, "Artificial Intelligence By Example", 1st Edition, O'Reilly, 2018.

REFERENCES

1. John Paul Mueller, Luca Massaron, "Artificial Intelligence for Dummies", 1st Edition, Kindle, 2018.
2. Tom Taulli, "Artificial Intelligence Basics: A Non-Technical Introduction", 1st Edition, Apress, 2019.

WEB REFERENCES

1. https://swayam.gov.in/nd1_noc20_cs81/preview
2. https://swayam.gov.in/nd1_noc20_me88/preview

20CS271 COMPUTER HARDWARE AND SOFTWARE LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the basic architecture of a Computing System and operations of various Components.	PO1
CO2:	Apply appropriate procedures for assembling, installation and configuration of the Hardware and Software System Components.	PO2, PO3, PO5
CO3:	Examine the security issues pertaining to the peripheral setup, Device Drivers, Network Devices and other External Devices for the Linux/Windows OS.	PO2, PO3, PO4, PO5

List of Exercises

1. Dismantling of PC for identification of Hardware components
   a) Identification of components in North and South Bridge of Motherboard
   b) Preparing cheat sheet for the major components in the PC
2. Assembling of External Peripherals with Motherboard
3. Installing Operating Systems and Device Drivers
   a) Bare metal installation of any one of the Linux and Windows flavors
   b) Installation of Dual Booting of OS
   c) Introduction to Virtualization platforms like Oracle VM Virtual Box/ VM Ware Player
   d) Understanding the importance of Legacy BIOS and UEFI mode of Booting
4. Identification of Network devices / Adaptors
   a) Identification of connecting devices like Switch, Router
   b) Exploring the usage of UTP, Optical Fibers in Networking
   c) Crimping of the RJ45 Jack with UTP
   d) Testing the connectivity using Tester tool
5. Configuring networking under Linux/Windows
   a) Installation of Network Drivers
   b) Exploring LAN Topology
   c) Configuring IPv4 Address on PCs for establishing communication
6. Identification of Server Platforms and Firewalls
   a) Classify the server platforms like File Server, Proxy Server, Web Server
   b) Exploring real World Cloud Infrastructures like GCP, AWS
   c) Exploring the security measures using Firewall
   d) Usage of Backup and Recovery Tools
   e) Awareness on Cyber threats

20CS272 PROGRAMMING PARADIGMS - I LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the programming environment, implementation and execution procedures.	PO2, PO3 PO5, PO12
CO2:	Develop simple programs using basic C Programing constructs.	PO2,PO3,PO5,PO12
CO3:	Apply programming concepts such as Arrays, Functions, Pointers and Structures for the implementation of solutions to real world problems.	PO2, PO3, PO4, PO5, PO12
CO4:	Examine the Control Flow and Data Flow in the Program, Test and Debug the occurrence of possible errors for bringing out a better solution.	PO2, PO3, PO4, PO5, PO12

List of Exercises

Lab 1:

- Introduction on Linux OS and its File Systems
- Working with basic Linux Commands

Lab 2:

- Practice with bits, bitwise operators and bitmasks
- Read and analyze C code that manipulates bits/ints
- Further practice with the edit-compile-test-debug cycle in the Linux environment

Lab 3:

- Experiment with float/double types and their operational behavior
- Observe the limitations of floating point representation/arithmetic
- Explore code that manipulates floats

Lab 4:

- Read and analyze C code that operates on chars and C-strings
- Use gdb and Valgrind to detect and debug memory errors

Lab 5:

- Investigate how Arrays and Pointers work in C
- Get further practice with gdb and valgrind
- Experiment with code that dynamically allocates Memory on the heap

Lab 6:

- Explore how C void*/function pointers support generic operations
- Study the implementation of generic operations and client call back functions
- Debug void* pitfalls

Lab 7:

- Study the relationship between C source and its assembly translation
- Use objdump and gdb to disassemble and trace assembly code

Lab 8:

- Become more familiar with useful GDB commands and tricks when working with assembly
- Observe and understand the correct operation of the runtime stack
- Diagnose symptoms of stack mismanagement

Lab 9:

- Experiment with different mechanisms for execution timing
- Run a profiler to get dynamic instruction counts

20CS291 PROGRAMMING FOUNDATIONS LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the programming environment, implementation and execution procedures.	PO1, PO2, PO3, PO5 PO9, PO10
CO2:	Develop simple programs using basic C Programing constructs.	PO1, PO2, PO3, PO5 PO9, PO10
CO3:	Apply programming concepts such as Arrays, Functions, Pointers and Structures for the implementation of solutions to real world problems.	PO1, PO2, PO3, PO4 PO5, PO9, PO10
CO4:	Examine the Control Flow and Data Flow in the Program, Test and Debug the occurrence of possible errors for bringing out a better solution.	PO1, PO2, PO3, PO4 PO5, PO9, PO10

List of Exercises

Lab 1:

- Introduction on Linux OS and its File Systems
- Working with basic Linux Commands
- Linux Tool Chains

Lab 2:

- Introduction to Linux Tool Chains
- Compilation, Linking, Executing the code in various stages

Lab 3:

- Practice with Bits, Bitwise Operators and Bitmasks
- Read and Analyze C code that manipulates bits/ints
- Further practice with the Edit-Compile-Test-Debug Cycle in the Linux environment

Lab 4:

- Experiment with Float/Double types and their operational behavior
- Observe the limitations of Floating Point representation/Arithmetic
- Explore Code that manipulates Floats

Lab 5:

- Read and Analyze C code that operates on Chars and C-Strings
- Use gdb to debug Programs

Lab 6:

- Investigate how Arrays and Pointers work in C
- Get further practice with gdb
- Experiment with code that dynamically allocates memory on the heap

Lab 7:

- Become more familiar with useful GDB commands and tricks when working with assembly
- Observe and understand the correct operation of the runtime stack
- Diagnose symptoms of Stack mismanagement

Lab 8:

- Experiment with different mechanisms for execution timing
- Run a profiler to get dynamic instruction counts

Lab 9:

- Experiment with File Handling
- Experiment with command line arguments

20CS204 PROGRAMMING PARADIGMS-II 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Relate the basic constructs in C++ and Java programming.	-
CO2:	Demonstrate OOP concepts with simple programs.	PO1,PO2,PO3
CO3:	Develop simple applications in Java.	PO2,PO3,PO5
CO4:	Analyze the real-life problem scenarios with object-oriented concepts.	PO2,PO3,PO4,PO11,PO12

OOPS CONCEPTS IN C++ **8**

Structure of C++ program - Class and Objects - Constructors - Inheritance -Functions: Virtual Function, Friend function, Static function - Operator overloading - Templates

JAVA **7**

Features of Java -Comparison of C, C++ with Java - Java Architecture- JDK, JRE, JVM - Keywords and Operators - Control statements - Java Array -Unicode System -String and StringBuffer.

OOP CONCEPTS IN JAVA **10**

OOP concepts - Class and Objects - Method, Constructors - this, static - instanceof Operator - Inheritance vs Aggregation - super -final - Polymorphism: Method overloading, overriding -Abstraction: Abstract class, Interface -Encapsulation: Package, Access modifiers.

EXCEPTION HANDLING, MULTITHREADING, FILE HANDLING IN JAVA **10**

Exception Handling: Exception types - Try and Catch Block - Finally block -Throw, Throws, finally clause -User defined Exception -Multithreading: Basics of a thread - Life cycle of a thread-Creating and Running a Thread -- Thread control and priority -Synchronization and Inter-Thread Communication - File handling and IO Streams.

GUI PROGRAMMING, JDBC, COLLECTIONS FRAMEWORK, WRAPPER CLASS **10**

GUI: Overview of Applet, Swing, AWT, Event Handling - JDBC: Introduction - JDBC Drivers -Establishing connection -Statements - Collection Framework: Introduction -List: Types, Iterators -Generics -Set -Map: Types - Wrapper classes.

Total Hours: 45

TEXT BOOKS

1. Herbert Schildt, "C++: The Complete Reference", 5th Edition, Tata McGraw- Hill, 2017.
2. Herbert Schildt, "The Complete Reference Java", 11th Edition, McGraw- Hill Education, 2019.

REFERENCES

1. Lafore R,"Object Oriented Programming in C++", Fourth Edition, SAMS, 2002.
2. Deitel H M and Deitel P J,"C++ How to Program", Pearson Education, Fourth Edition, 2002.
3. Arnold, Gosling and Holmes, "The Java Programming Language", 3rd Edition, AddisonWesley, 2000.
4. Stroustrup B,"C++ Programming Language", Special Third Edition, Addison Wesley Professional, 2000.

WEB REFERENCES

1. https://nptel.ac.in/courses/106/105/106105191/
2. https://academy.oracle.com/pages/java_programming_course.pdf
3. https://www.coursera.org/specializations/core-java

20CS273 PROGRAMMING PARADIGMS - II LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Develop programs using control structures in C++ and Java.	PO1,PO2,PO3
CO2:	Develop programs using concepts of Object Oriented Programming.	PO1,PO2,PO3
CO3:	Develop various java applications and GUI programming concepts.	PO2,PO3,PO5
CO4:	Develop applications using JDBC and Collection framework.	PO2,PO3,PO4,PO11,PO12

List of Excerises

1. Simple programs in C++ basic concepts.
2. Simple programs in Java to demonstrate the usage of Control structures and arrays.
3. Simple programs in Java to illustrate the usage of class and objects with constructors and keywords.
4. Real time application programs to illustrate the use of Inheritance with its key elements.
5. Simple programs to differentiate the concepts of polymorphism.
6. Real time application on Abstraction and Interface.
7. Simple real time application programs to illustrate the use of Packages.
8. Simple real time application programs to illustrate the use of Multi Threads and Exception handling.
9. Demonstration of the GUI programming using Applet, Swing, AWT Technology
10. Illustration of File operations.
11. JDBC connectivity.
12. Applications using Collection Framework.

Tools suggested:

Eclipse IDE

20CS210 PROGRAMMING PARADIGMS-III 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Relate the core syntax and semantics of programming constructs to Python programming language	-
CO2:	Interpret the knowledge of Python Libraries for solving real world problems	PO1, PO4, PO5
CO3:	Build robust applications using Python programming language features	PO1, PO3, PO5
CO4:	Examine the python programming constructs and features to solve the problems in diversified domains	PO1, PO2, PO4, PO5

PROGRAMMING CONSTRUCTS IN PYTHON **8**

Basic Python: Multiparadigm language, Variables, Expressions and Statements, Conditional Execution Iteration - Lists and Strings, Deep and Shallow Copy, Tuples and Dictionaries, Set and Frozen Sets, Functions -Lambda Function - Recursion - Exception Handling - Files -Regular Expression - Object Oriented Concepts in Python- Python Classes and Inheritance.

NETWORK PROGRAMMING AND GUI **6**

Network Programming -Introduction to Sockets: Communication Endpoints - Network Programming in Python - Internet Client Programming -Transferring Files -GUI Programming -Introduction to Tkinter and Python Programming - Tkinter Examples -A Brief Tour of Other GUIs.

WEB PYTHON PROGRAMMING **9**

Database Programming -Introduction - Python DB - API - ORMs - Non-Relational Databases - Related References - Extending Python -Extending Python by Writing Extensions -Web Clients and Servers -Python Web Client Tools - Web Clients - Web (HTTP) Servers -Web Programming: CGI -Helping Web Servers Process Client Data -Building CGI Applications - Using Unicode with CGI.

APPLICATION DEVELOPMENT IN PYTHON **10**

Web Frameworks: Django -Introduction - Web Frameworks - Introduction to Django - Projects and Apps - Creating a Model to Add Database Service - The Python Application Shell - The Django Administration App - Creating the Blog's User Interface - Improving the Output - Working with User Input - Forms and Model Forms - Unit Testing - An Intermediate Django App: The TweetApprover - Resources.

SERVICES AND PROTOCOLS **12**

Cloud Computing: Google App Engine -Introduction - The Sandbox and the App Engine SDK - Choosing an App Engine Framework - Python 2.7 Support - Comparisons to Django - Morphing "Hello World" into a Simple Blog - Web Services -The Yahoo! Finance Stock Quote Server - Microblogging with Twitter.

Total Periods : 45

TEXT BOOKS

1. Dr. Charles R. Severance, "Python for Everybody", 2nd edition, Severance Publications, 2016.
2. Wesley J. Chun, "Core Python Application Programming", 3rd edition, Prentice Hall, 2012.

REFERENCES

1. Michel Anders, "Python 3 Web Development Beginner's Guide", Packt Publishing Limited, 2011.
2. SanjeevJaiswal, Ratan Kumar, "Learning Django Web Development", Packt Publishing Limited, 2015.

WEB REFERENCES

1. https://infytq.onwingspan.com/en/infytq-login
2. https://www.coursera.org/specializations/python
3. https://nptel.ac.in/courses/106/106/106106182/

20CS278 PROGRAMMING PARADIGMS -III LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Relate the fundamental notions and techniques used in Python programming.	-
CO2:	Interpret problem solving through python programming	PO1, PO4, PO5
CO3:	Build simple models using open-source Python Web Framework	PO1, PO3, PO5
CO4:	Examine the python programming constructs and features to solve problems in diversified domains	PO1, PO2, PO4, PO5

List of Excerises

1. Describe the Python language syntax including control statements, loops and functions to write programs for a wide variety problem in mathematics and science.
2. Interpret the concepts of Object-oriented programming as used in Python using encapsulation, polymorphism and inheritance.
3. Deprecate the performance of Regular Expression using Python to perform the following:

   Find and Replace options in Text File

   Password setting and its Violations based on Standards
4. Development of Client/Server based Python Modules to perform the following:

   File transfer using TCP/IP

   Chatting using UDP
5. Model Producer-Consumer strategy using Queue with and without Threading and analysis its execution methodology.
6. Design of Registration forms with various GUI components to throw action and handle its response in the backend using Tkinter.
7. Design of Web based Python applications using Python-DB API as Backend.
8. Application development using Django Framework like:

   Creating Blogs

   Integrating with existing Templates
9. Data Extraction from Facebook and Twitter sites using Python Based APIs

20CS243 DATA STRUCTURES AND ALGORTIHM ANALYSIS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe various data structures and algorithms for problem solving	PO1,PO2,PO3
CO2:	Choose appropriate data structures and algorithms for better problem solving.	PO1, PO2, PO3 , PO4
CO3:	Solve computational problems using efficient algorithms and data structures	PO1, PO2, PO3, PO4
CO4:	Discriminate the performance of various algorithms and its background data structures	PO1,PO2, PO3,PO4

LINEAR DATA STRUCTURES **12**

Storage Class Specifiers - Arrays and its Representations - Stack ADT - Implementation of Stack and its Applications - Queue ADT - Implementation of Queue and its Applications - List ADT - Linked List Implementation -Doubly Linked Lists - Circularly Linked Lists.

Complexity Analysis: Time and Space complexity of algorithms, asymptotic analysis, big O and other notations, importance of efficient algorithms, program performance measurement.

NON LINEAR DATA STRUCTURES **10**

Tree ADT - Tree Traversals - Binary Tree ADT - Applications of Trees - Binary Search tree ADT -Binary Search tree traversals -BST time complexity analysis. Graph and its Representations - Graph Traversals -DFS -BFS -time complexity analysis of Graph Traversals

SORTING AND SEARCHING TECHNIQUES **8**

Preliminaries - Insertion Sort - Bubble sort -Selection sort - Heap sort - Merge sort - Quick sort - Linear Search - Binary Search -Time Complexity analysis of sorting and search algorithms.

Total Periods : 30

TEXT BOOKS

1. Weiss M.A., "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2007
2. Anany Levitin. "Introduction to the design and analysis of algorithms", Pearson Education, 2019.

REFERENCES

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", MIT Press, 2009
2. Tenenbaum M., Langsam Y., and Augenstein M.J. "Data Structures using C", Pearson Education, 2009.
3. Ellis Horowitz and Sartaj Sahni, "Fundamentals of Data Structures", 2nd Edition, GalgotiaBook Source, Gurgaon,1976

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1. https://nptel.ac.in/courses/106/102/106102064/
2. http://web.stanford.edu/class/cs166/
3. https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
4. https://visualgo.net/en

20CS292 DATA STRUCTURES AND ALGORITHM ANALYSIS LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Experiment with basic operations on linear data structures	PO1, PO2, PO3
CO2:	Make use of dynamic memory allocation for implementing non-linear data structures	PO1, PO2, PO3, PO4
CO3:	Develop simple applications using linear and non-linear data structures	PO1, PO2, PO3, PO4
CO4:	Utilize various searching and sorting techniques to provide algorithmic solution	PO1, PO2, PO3, PO4

List of Excerises

1. Implementation of Stack and Queue using static memory allocation
2. Implementation of List using dynamic memory allocation
3. Implementation of Construction of Binary Search Tree and its Traversals and analyzing the time complexity
4. Implementation of Sorting Techniques and analyzing the time complexity of various sorting
5. Implementation of Searching Techniques and analyzing the time complexity of searching

Total Periods : 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE201 ELECTRIC CIRCUITS 3 0 0 3

Course Outcome

On successful completion of the course, students will be able to

CO1:	Infer the values of the current and voltage by applying laws and network theorems	PO1, PO2, PO5
CO2:	Rephrase the complex circuits to simple circuits using network reduction techniques and Source transformations	PO1, PO2 PO5, PO9, PO10
CO3:	Interpret the values ofimpedance, admittance, power and power factor of single phase and three phase AC circuits	PO1, PO2 PO5
CO4:	Outline the concepts of series and parallel RLC circuits	PO1, PO2 PO5, PO9, PO10
CO5:	Illustrate the principles of resonant circuits	PO1, PO2
CO6:	Understand the transient analysis of Electric Circuits	PO1, PO2, PO5, PO9, PO10

DC CIRCUIT ANALYSIS **15**

Charge, Current, Voltage, Power and Energy -Ideal voltage and current sources -Independent sources-Dependent sources- Circuits elements - Voltage and Current division in series and parallel circuits - Network analysis using Mesh and nodal analysis -Source transformation- Star delta transformation- Circuit theorems: Thevenin, Norton, Superposition, Reciprocity and Maximum Power transfer theorem

AC CIRCUIT ANALYSIS **15**

Sinusoidal voltage and current- RMS value- Form factor -Phasor representation of sinusoidal voltage and Current, Voltage and Current relationship in R,L and C Circuits-Impedance and Admittance- Power factor concepts in RL, RC and RLC circuits-Impedance combination- Real power-Reactive power, Complex power, Apparent power-Analysis of simple series and parallel circuits, concepts of three phase circuits

Computer Aided Analysis of DC and AC Circuits using PSpice

RESONANCE AND COUPLED CIRCUITS **15**

Series and Parallel Circuits -Half power frequencies-Bandwidth and Q Factor of Resonant circuits - Self and Mutual Inductance - Dot Convention-Coefficient of coupling -Sinusoidal steady state analysisof coupled Circuits - Transient analysis of Electric Circuits

Total Hours: 45

TEXT BOOKS

1. John Bird, "Electric Circuit Theory and Technology", 4th Edition, Newnes Publication, 2010.
2. Charles. K. Alexander, Mathew .N.OSadiku, "Fundamentals of Electric Circuits", 5th Edition, Mc GrawHill Publications, 2013.

REFERENCES

1. Joseph A.Edminister, MahmoodNahri, "Electric Circuits", Schaum's Series, 5th Edition, McGrawHill Publications., 2010.
2. William H.Hayt, Jack E.Kemmerly and Steven M.Durbin, "Engineering Circuit Analysis", 8th Edition, McGrawHill Publications, 2013.

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1. https://nptel.ac.in/courses/117106108/
2. https://nptel.ac.in/courses/108102042/
3. https://nptel.ac.in/courses/108105053/
4. www.vidyathiplus.in/2011/11electronic-device-and-circuits-edc.html/

20EE236 PRINCIPLES OF ELECTRICAL ENGINEERING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the construction and operation of DC machines	PO1
CO2:	Explain the construction and operation of transformers	PO1,PO2
CO3:	Describe the construction, operational details of induction motors and its applications	PO1,PO2
CO4:	Summarize the concepts of special machines and its applications	PO1,PO2,PO5,PO9,PO10

DC MACHINES **11**

Construction of DC machines - Principle of operation of DC generators - EMF equation - Types of DC generators and their characteristics - Principle of operation of DC motors - Types of DC motors and their characteristics - Starters - Speed control of DC motors - DC machine application.

TRANSFORMERS **9**

Construction and principle of operation of single phase transformer - EMF equation - Types - transformer on no-load and load - Equivalent circuit - Open circuit and short circuit tests.

INDUCTION MOTORS **12**

Construction and principle of operation of 3-phase induction motor - Types - Slip - Torque characteristics - Starting methods - Speed control methods - Single-phase induction motor: Construction and principle of operation, types - Applications.

SPECIAL MACHINES AND ITS APPLICATIONS **13**

Stepper motors - Types- Synchronous motor - Reluctance motor and hysteresis motor - Switched Reluctance Motor (SRM) - Universal motor - Brushless DC (BLDC) Motor, DC and AC servomotor.

Total Hours: 45

TEXT BOOKS

1. Gupta J. B, "Theory and Performance of Electrical Machines', 14th Edition, S.K.Kataria and Sons, 2009.
2. Kothari D. P. and Nagrath I. J., "Electric Machines', 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., 2004.

REFERENCES

1. Theraja B. L., "Electrical Technology Vol. II AC/DC Machines", 2nd Edition, S. Chand and Company Ltd., 2008.
2. Mehta V.K. and Rohit Mehta, "Principles of Power System", 3rd Edition, S.Chand and Company Ltd., 2006
3. Mittle.V.N. and Arvind Mittle, "Basic Electrical Engineering", 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.

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1. https://nptel.ac.in/courses/108/108/108108076/
2. https://nptel.ac.in/courses/108/105/108105053/
3. https://nptel.ac.in/courses/108/105/108105017/

20EE237 FOUNDATIONS OF ELECTRICAL ENGINEERING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Summarize the basic laws and apply them to solve the Electric circuits	PO1, PO2, PO5
CO2:	Outline the principle and operation of DC machines, AC machines and transformers	PO1, PO2, PO9, PO10
CO3:	Illustrate the different types of measuring instruments and sensors	PO1, PO2, PO9, PO10
CO4:	Demonstrate the various electrical safety systems	PO1, PO2, PO6, PO9, PO10
CO5:	Explain the importance of illumination	PO1, PO2, PO6, PO9,PO10

ELECTRIC CIRCUITS **10**

Introduction to DC and AC circuits - Active and Passive elements - Ohm's law - Kirchhoff's law - Voltage and Current relations for R, L, C - Generation of AC - Average and RMS values - Power and Power factor - Introduction to three phase systems - Types of connections, relationship between line and phase values.

ELECTRICAL MACHINES AND TRANSFORMERS **10**

Working principle, construction and applications of DC machines and AC machines - Introduction to three phase induction motors

Construction and Principle of operation of Transformers - Single phase and Three phase transformers

MEASURING INSTRUMENTS AND SENSORS **10**

Basic principles and classification of instruments-Measurement of single phase and three phase power - Energy meter - Vibration measurement - Piezo electric transducers - Humidity and moisture measurement

Satellite Imaging and sensing sensor, light sensor - Fiber -optic based radiation measurement.

ELECTRICAL SAFETY, WIRING **8**

Safety measures in Electrical systems - Types of wiring - Service mains, Meter and Distribution Board - Basic principles of Earthing - Measurement of Earth resistance - Types of Earthing - Protective devices: Fuses, MCB, ELCB

ILLUMINATION **7**

Energy Efficient Lamps - Types of lamps - Requirements of Good Lighting - Design of Illumination schemes.

Total Hours: 45

TEXT BOOKS

1. Muthusubramanian .R, Salaivahanan .S, "Basic Electrical and Electronics Engineering", Tata McGraw Hill, 6th Reprint, 2011.
2. Sawhney .A.K, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Sons, 2004.

REFERENCES

1. Kothari .D.P &Nagrath.I.J, "Electric Machines", 5th Edition, Tata McGraw Hill Education Private Limited, 2017.
2. Gupta .J .B, "Theory and Performance of Electrical Machines", 14th Edition, S. K. Kataria and Sons, 2009.
3. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, PHI Learning, 2007.
4. M. A. Cayless and A. M. Marsden, "Lamps and lighting", Taylor and Francis Group, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/108/108108076/
2. https://nptel.ac.in/courses/108/105/108105053/
3. https://nptel.ac.in/courses/117/106/117106108/

20EE240 FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Solve the electric circuits by relating the basic laws of Electrical Engineering.	PO1, PO2, PO5
CO2	Describe the construction and operation of DC machines, transformers and induction motors	PO1, PO2, PO5
CO3	Compare the different types of motors pertaining to their industrial applications.	PO1, PO2, PO5
CO4	Outline the characteristics of semiconductor devices, electronic circuits and their applications.	PO1, PO2, PO5
CO5	Demonstrate the real-time applications using AVR RISC Microcontroller and ARDUINO.	PO1, PO2, PO5, PO9, PO10

ELECTRIC CIRCUITS **8**

Ohm's law, Kirchhoff's law - Series and Parallel connections - Solving simple DC Circuits - Single phase AC circuit fundamentals - Power, Power factor - Solving simple AC Circuits - Three phase AC circuits - Star and Delta Connections

DC MOTORS **5**

Principle of operation - Types - Significance of Back EMF - Speed, Torque - Speed-Torque characteristics - Losses and Efficiency - Speed control of DC motor - Electric Braking - Applications

TRANSFORMERS AND AC MOTORS **6**

Single Phase Transformer - Construction and Principle of operation - Types - Auto Transformer - Applications

Three phase Induction Motor - Construction -Principle of operation - Types - Torque equation - Speed-Torque characteristics - Single phase Induction Motor - Principle of operation and Applications Introduction to Alternators

INDUSTRIAL APPLICATIONS **4**

Motor Selection - Factors to be considered - Power rating - Types of Duty Cycle - Selection of motors for machine tool applications and centrifugal pumps

ELECTRONICS **10**

PN Junction Diodes, BJT construction and working principle - Circuits: Rectifier, Power supply, Voltage Regulator - Basics of Amplifiers and Oscillators - Integrated Circuits: Operational amplifiers - Characteristics and applications. Digital Circuits - A/D and D/A

AVR RISC MICROCONTROLLER AND APPLICATIONS **12**

Overview of AVR RISC architecture - Getting started with ARDUINO IDE - C Language basics- Programs using ARDUINO - Interfacing ARDUINO with Pressure, Temperature and Speed sensors - Bluetooth and Ethernet

Total Periods: 45 hours

TEXTBOOKS

1. Muthusubramanian .R, Salaivahanan .S, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, 2nd Edition, 2011.
2. Thomas .L Floyd, "Electronic Devices Conventional Current Version", Pearson, 10th Edition, 2018.
3. Thomas Grace,"Programming and Interfacing ATMEL's AVRs", 1st Edition, Cengage Learning, 2016.

REFERENCES

1. Nagrath .I .J, Kothari .D .P, "Electrical Machines", Tata McGraw Hill, 5th Edition, 2017.
2. Pillai.S.K, "A First Course on Electrical Drives", New Age International Publications Limited, 2011.
3. Robert .L Boylestad, Louis Nashalskey, "Electronic Devices and Circuits", PearsonEducation, India, 11th Edition, 2015.
4. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson, 6th Edition, 2017.
5. Simon Monk, "Programming Arduino, Getting Started with Sketches", McGraw Hill Education, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/108/108108076/
2. https://nptel.ac.in/courses/108/105/108105053/
3. https://nptel.ac.in/courses/108/105/108105017/
4. https://nptel.ac.in/courses/122/106/122106025/

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE281 FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY 0 0 2 1

Course Outcomes

On successful completion of the course, students will be able to

CO1	Infer the different laws of Electrical Engineering and interpret the results	PO1, PO2, PO4,PO5
CO2	Analyse the various speed control techniques and load test in DC shunt motors and Induction motor	PO1, PO2, PO4,PO5
CO3	Evaluate the performance characteristics of semiconductor diode	PO1, PO2, PO4,PO5
CO4	Design and implement the real-time applications of Electric and Electronic circuits.	PO1, PO2, PO4,PO5
CO5	Communicate the results of the experiments through reports	PO1, PO2, PO4,PO5

LIST OF EXPERIMENTS

1. Verification of Ohm's Law and Kirchhoff's law
2. Measurement of resistance, inductance and capacitance
3. Load test on DC motor
4. Speed Control of DC motor
5. Load Test on Three phase Induction Motor
6. Speed Control of Three phase slip ring IM
7. VI characteristics of PN junction diode
8. Simulation of Electric circuits
9. Design of Regulated Power Supply
10. Real-time applications using ARDUINO

Total Periods: 30 hours

ENLIGHTENMENT THROUGH EDUCATION SREC

20EC204 DIGITAL SYSTEM DESIGN 3 0 0 3

PREREQUISITES

20EC201 - Electron Devices

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Interpret the principles of Boolean algebra to manipulate and minimize logic expressions	PO1, PO2, PO3, PO5, PO12
CO2:	Design the combinational logic circuits	PO1, PO2, PO3, PO5, PO12
CO3:	Construct finite state machines using sequential circuits	PO1, PO2, PO3, PO5, PO12
CO4:	Explain the concepts of logic families and memory devices	PO1, PO2, PO3, PO5, PO12
CO5:	Describe the concepts of Verilog HDL	PO1, PO2, PO3, PO5, PO12

FUNDAMENTALS OF DIGITAL SYSTEMS **5**

Digital Abstraction - Number System and Codes - Boolean algebra and logic gates - From Logic to Gates - Simplification of Switching Functions - Karnaugh Map Method - Quine-McCluskey Technique.

COMBINATIONAL LOGIC CIRCUITS **10**

Analysis of combinational logic circuits - Arithmetic Circuits - Magnitude comparator - Decoders / Encoders - Multiplexers / Demultiplexers - Code converters - Parity circuits - Applications of combinational logic circuits

SEQUENTIAL LOGIC CIRCUITS **15**

Models for Sequential logic circuits - Flip-flops - Analysis of clocked synchronous sequential circuits - Mealy and Moore machines - Finite state machine - State minimization/reduction, state assignment - Applications - Counters - Registers - Types of Asynchronous logic circuits - Analysis and Synthesis of Fundamental mode Asynchronous logic circuits - Introduction to pulse mode asynchronous sequential circuits - Cycles - Races - Hazards.

LOGIC FAMILIES AND MEMORY DEVICES **6**

Characteristics of Digital ICs, DTL, TTL, ECL, Calculation of noise margins and fan-out. Memory: Basic Organization, ROM, RAM, PROM, EPROM, EEPROM - PLDs, - FPGA - Design of combinational circuits using PLDs.

HARDWARE DESCRIPTION LANGUAGE **9**

Introduction to VLSI design - Design flow - Hierarchical Modelling Concepts - Modules & Ports - Modelling techniques - Tasks and Functions - User defined primitives - Realization of combinational and sequential circuits using Verilog HDL

CASE STUDY:

Systematic design approach for Leap Year Calculation, Digital Combination Lock

Total Hours: 45

TEXT BOOKS

1. Morris Mano, "Digital Design", 6th Edition, Pearson Education Ltd., 2018.

2. Randy H. Katz, Gaetano Borriello, "Contemporary Logic Design", 2nd Edition, Prentice Hall, 2005.

3. Samir Palnitkar, "Verilog HDL", Prentice Hall, 2010.

REFERENCE BOOKS

1. Ronald J. Tocci, "Digital Systems: Principles and Applications", 12th Edition, Pearson Education, 2017.

2. Charles H.Roth, "Fundamentals of Logic design", 7th Edition, Thomson Learning, 2014.

3. Victor P. Nelson, H. Troy Nagle, J. David Irvin, Bill D. Carol, "Digital logic Analysis and design", 2nd edition, Pearson Education, 2019

4. S. Brown and Z. Vranesic, Fundamentals of Digital Logic with Verilog Design, Tata Mc-Graw Hill, 2008.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee10

2. https://onlinecourses.nptel.ac.in/noc21_ee39

ENLIGHTENMENT THROUGH EDUCATION SREC

Course Outcome

On successful completion of the course, students will be able to

CO1:	Outline the principles of electrical, electronics and instrumentation engineering	PO1
CO2:	Explain the concepts and properties of measuring system	PO1, PO 2
CO3:	Infer the components of power systems and calculate the electrical tariff	PO1, PO2
CO4:	Summarize the various electrical safety and standards	PO1, PO2
CO5:	Demonstrate the ability to measure various electrical quantities	PO1, PO2, PO5, PO9, PO10
CO6:	Relate the concepts of single phase and three phase systems in residential wiring	PO1, PO2, PO5, PO9, PO10

INTRODUCTION **6**

History - Major Inventions - Scope - Significance and Job Opportunities in Electrical, Electronics and Instrumentation Engineering - Overview of various Energy Resources

MEASURING SYSTEM **8**

Introduction to Basic Instruments - Classification of Instruments - Error in Measurement - Noise - Accuracy and Precision - Linearity - Hysteresis - Threshold - Dead Time and Zone - Resolution - Loading Effect

ENERGY AND TARIFF **8**

Basics of Energy Conversion - Power Apparatus used in Power Generation, Transmission and Distribution - Power Apparatus used in Various Industries - Basic ideas about Utility Supply - Types of load - Load curve - Load duration curve - Electrical Tariff - Energy Audit - Importance of Energy saving

STANDARDS AND SAFETY **8**

Introduction to various standards like IEEE, IEC, IS, Regulatory Bodies, National Electrical Safety Code - Standard of Electrical Safety in work place - Occupational Safety and Health Administration Standards - Indian Electricity Acts related to Electrical Safety - Basic Safety Measures at Home and Industry.

HANDS ON EXPERIMENTS

1. Measurement of Electrical Quantities: Voltage, Current, Power and Power Factor in RLC Circuit
2. Measurement of Winding Resistance and Insulation Resistance
3. Measurement of Energy using single phase energy meter
4. Calibration of single phase energy meter
5. Measurement of earth resistance of electrical equipment
6. Residential house wiring using Switches, Fuse, Lamp, and Energy Meter
7. Staircase wiring model

8. Fluorescent lamp wiring
9. Study experiment about various electrical safety standards
10. Energy Audit - Case study

Total Hours: 30 hours Theory + 30 hours Practicals

TEXT BOOKS

1. Kothari .D .P and Nagrath .I .J, "Basic Electrical Engineering", 3rd Edition, Tata McGraw-Hill, 2010.
2. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield., "Electrical Safety Handbook", McGraw Hill Education, 5th Edition, 2019.

REFERENCES

1. Clayton Paul, Syed A Nasar and Louis Unnewehr, "Introduction to Electrical Engineering", 2nd Edition, McGraw Hill, 1992.
2. Toro .V .D, "Basic Electrical Engineering", 2nd Edition, PHI Learning, 2014.
3. Kulshreshtha .D .C, "Basic Electrical Engineering", Revised 2nd Edition, McGraw Hill, 2017.
4. Maxwell Adams .J, "Electrical Safety - A Guide to Causes and Prevention of Electric Hazards", The Institution of Electric Engineers, 1994.
5. Mehta V.K. and Rohit Mehta., "Principles of Power System", 4th Edition, S. Chand Publication, 2005.
6. Sawhney .A .K, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Co, 2015.

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1. https://nptel.ac.in/courses/108108076/
2. https://www.khanacademy.org/science/physics/circuits-topic/circuits-resistance
3. https://www.electriltechnology.org/2013/09/electrical-wiring.html
4. https://www.electricaltechnology.org/2013/10/how-to-electrical-electronics-engineering-tutorials.html
5. https://www.coursera.org/browse/physical-science-and-engineering/electrical-engineering

20EE261 ELECTRICAL AND ELECTRONICS ENGINEERING 3 0 2 4

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Solve the electric circuits by relating the basic laws	PO1, PO2, PO5
CO2:	Describe the construction and operation of DC machines, transformers and induction motors	PO1, PO2, PO5
CO3:	Compare the different types of motors pertaining to their industrial applications	PO1, PO2, PO5
CO4:	Outline the characteristics of semiconductor devices, electronic circuits and their applications	PO1, PO2, PO5
CO5:	Demonstrate the real-time applications using AVR RISC Microcontroller and ARDUINO	PO1, PO2, PO5, PO9, PO10
CO6:	Experiment with simple application circuits using Electrical and ElectronicsEngineering	PO1, PO2, PO5, PO9, PO10

ELECTRIC CIRCUITS **8**

Ohm's law, Kirchhoff's law - Series and Parallel connections - Solving simple DC Circuits - Single phase AC circuit fundamentals - Power, Power factor - Solving simple AC Circuits - Three phase AC circuits - Star and Delta Connections

DC MOTORS **5**

Principle of operation - Types - Significance of Back EMF - Speed, Torque - Speed-Torque characteristics - Losses and Efficiency - Speed control of DC motor - Electric Braking - Applications

TRANSFORMERS AND AC MOTORS **6**

Single Phase Transformer - Construction and Principle of operation - Types - Auto Transformer - Applications

Three phase Induction Motor - Construction -Principle of operation - Types - Torque equation - Speed-Torque characteristics - Single phase Induction Motor - Principle of operation and Applications

Introduction to Alternators

INDUSTRIAL APPLICATIONS **4**

Motor Selection - Factors to be considered - Power rating - Types of Duty Cycle - Selection of motors for machine tool applications and centrifugal pumps

ELECTRONICS **10**

PN Junction Diodes, BJT construction and working principle - Circuits: Rectifier, Power supply, Voltage Regulator - Basics of Amplifiers and Oscillators - Integrated Circuits: Operational amplifiers - Characteristics and applications. Digital Circuits - A/D and D/A

AVR RISC MICROCONTROLLER AND APPLICATIONS **12**

Overview of AVR RISC architecture - Getting started with ARDUINO IDE - C Language basics- Programs using ARDUINO - Interfacing ARDUINO with Pressure, Temperature and Speed sensors - Bluetooth and Ethernet

HANDS ON EXPERIMENTS

1. Verification of Ohm's Law and Kirchhoff's law
2. Measurement of resistance, inductance and capacitance
3. Load test on DC motor
4. Speed Control of DC motor
5. Load Test on Three phase Induction Motor
6. Speed Control of Three phase slip ring IM
7. VI characteristics of PN junction diode
8. Simulation of Electric circuits
9. Design of Regulated Power Supply
10. Real-time applications using ARDUINO

Total Hours: 45 hours Theory + 30 hours Practicals

TEXTBOOKS

1. Muthusubramanian .R, Salaivahanan .S, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, 2nd Edition, 2011.
2. Thomas .L Floyd, "Electronic Devices Conventional Current Version", Pearson, 10th Edition, 2018.
3. Thomas Grace,"Programming and Interfacing ATMEL's AVRs", 1st Edition, Cengage Learning, 2016.

REFERENCES

1. Nagrath .I .J, Kothari .D .P, "Electrical Machines", Tata McGraw Hill, 5th Edition, 2017.
2. Pillai.S.K, "A First Course on Electrical Drives", New Age International Publications Limited, 2011.
3. Robert .L Boylestad, Louis Nashalskey, "Electronic Devices and Circuits", Pearson Education, India, 11th Edition, 2015.
4. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson, 6th Edition, 2017.
5. Simon Monk, "Programming Arduino, Getting Started with Sketches", McGraw Hill Education, 2012.

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1. https://nptel.ac.in/courses/108/108/108108076/
2. https://nptel.ac.in/courses/108/105/108105053/
3. https://nptel.ac.in/courses/108/105/108105017/
4. https://nptel.ac.in/courses/122/106/122106025/

20EE262 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING 2 0 2 3

Course Outcome

On successful completion of the course, the students will be able to

CO1:	Outline the basic principles of Electrical Engineering	PO1, PO2, PO5
CO2:	Explain the concepts of Electromagnetism and magnetic circuits	PO1, PO2
CO3:	Infer the principles of measuring system	PO1, PO2
CO4:	Summarize theknowledge on semiconductor devices, features and its application	PO1, PO2, PO5
CO5:	Experiment with simple circuits using the concepts of electrical and electronicsengineering	PO1, PO2, PO5, PO9, PO10

INTRODUCTION TO ELECTRICAL ENGINEERING **10**

Overview of Electrical Engineering - Current and Voltage - Power and Energy - Resistance in series and parallel - Ohm's Laws - Kirchoff's Voltage Law - Kirchoff's Current Law - Node-Voltage Analysis, Mesh-Current Analysis, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem and Superposition Theorem

ELECTROMAGNETISM AND MAGNETIC CIRCUITS **5**

Magnetic field - Magnetic Circuits - Inductance and Mutual Inductance -Working principle of Transformers

MEASURING INSTRUMENTS **6**

Basic principles and classification of instruments - Moving coil and Moving iron instruments - Measurement of single phase and three phase power - Energy meter

FUNDAMENTALS OF SEMICONDUCTOR AND DIODE THEORY **9**

Review of Intrinsic and Extrinsic Semiconductors - PN Junction Diode - Power Supply Circuit - Zener Diode - Voltage Regulator - BJT construction and working principle - BJT configurations - JFET construction and working - MOSFET construction and working - Characteristics and its applications

HANDS ON EXPERIMENTS

1. Measurement of resistance, inductance and capacitance
2. Verification of Circuit Laws and Network Theorems
3. Load Test on Single phase Transformer
4. Measurement of single phase power with R load
5. Measurement of Three phase Power with R load
6. VI Charactersistics of PN junction and Zener Diode
7. VI Characteristics of BJT
8. VI Characteristics of JFET and MOSFET

Total Hours: 30 Hours Theory + 30 Hours Practical's

TEXT BOOKS

1. R.Muthusubramanian, S.Salivahanan, "Basic Electrical, Electronics and Computer Engineering", 18th Reprint, Tata McGraw Hill Education Private Limited, 2014.
2. A. K. Sawhney, "A course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Sons, 2015.

3. Salivahanan.S, Suresh Kumar.N and Vallavaraj .A, "Electronic Devices and Circuits", 3rd Edition, McGraw Hill Publications, 2012.

REFERENCES

1. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, PHI Learning, 2007.
2. Jacob Millman, Christos C.Halkias, "Electronic Devices and Circuits", 3rd Edition, McGraw Hill Publications, 2012.
3. Mittle V. N. and Arvind Mittle, "Basic Electrical Engineering", 2nd Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.
4. John Bird, "Electric Circuit Theory and Technology", 4th Edition, Newnes Publication, 2010.
5. Charles. K. Alexander, Mathew. N. O. Sadiku, "Fundamentals of Electric Circuits", 5th Edition, Mc GrawHill Publications, 2013.

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3. https://nptel.ac.in/courses/117/106/117106108/

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE270 ELECTRIC CIRCUITS AND ELECTRON DEVICES LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Infer the different laws and network theorems	PO1, PO2, PO5, PO9, PO10
CO2:	Interpret the device characteristics using software tools	PO1, PO2, PO5, PO9, PO10
CO3:	Demonstrate simple application circuits using electrical and electronic components	PO1, PO2, PO5, PO9, PO10
CO4:	Inferthe characteristics of semiconductor devices	PO1, PO2, PO5, PO9, PO10

LIST OF EXPERIMENTS

1. Measurement of resistance, inductance and capacitance.
2. Verification of Circuit Laws and Network Theorems.
3. Electric Circuit Simulation Using PSPICE and Multisim.
   - ii. Steadystate analysis of DC circuits.
   - iii. Steady state analysis of single and three phase AC coupled circuits.
   - iv. Transient analysis of RL, RC and RLC Circuits.
   - v. Frequency Response of circuits A) Series Resonance B) Parallel Resonance.
4. Applications.
   - i. Design of mobile charger.
   - ii. Design of Voltage Doubler circuit.
   - iii. PCB design and testing of Simple Circuits.
5. Characteristics of PN junction diode and application as a rectifier
6. Characteristics of Zener diode and application as a voltage regulator
7. Characteristics of BJT and analysis of CE amplifier circuit with various biasing methods
8. Characteristics of JFET and analysis of CS amplifier circuit with various biasing methods
9. Analysis of MOSFET and application as a switch
10. Characteristics of Optoelectronic Devices
11. Design of DC regulated power supply
12. Characteristics of UJT

20EE202 NETWORK ANALYSIS AND SYNTHESIS 2 1 0 3

PREREQUISITES

20EE201 - Electric Circuits

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Infer the basic concepts of graph theory	PO1, PO2, PO5
CO2:	Interpret the inter-relationship between two port network parameters, construct ladder and lattice networks.	PO1, PO2, PO5, PO9, PO10
CO3:	Solve network functions of two port networks and interpret the properties of driving point and transfer functions.	PO1, PO2, PO5
CO4:	Design RL, RC and LC driving point impedance and admittance functions.	PO1, PO2, PO5, PO9, PO10
CO5:	Infer the fundamentals of various types of filter circuits.	PO1, PO2, PO5, PO9, PO10

GRAPH THEORY **9**

Graph of a Network - Definitions - Tree - Co tree - Link - Basic loop and basic cut set - Incidence matrix - Cut set matrix - Tie set matrix - Duality.

TWO PORT NETWORKS **9**

Characterization of LTI two port networks - Z, Y, ABCD and h parameters - Reciprocity and symmetry - Inter relationships between the parameters - Ladder and Lattice networks.

NETWORK FUNCTIONS **9**

Concept of complex frequency - Transform impedances - Network functions of one port and two port networks - Concept of poles and zeros - Properties of driving point and transfer functions - Time response and stability from pole zero plot.

NETWORK SYNTHESIS **9**

Realization concept - Hurwitz property - Positive real functions - Properties - Synthesis of RL, RC, LC driving point impedance and admittance functions using Foster and Cauer forms

FILTERS **9**

Image parameters and characteristics impedance- Passive and active filters fundamentals - Low pass filters - High pass filters.

Total Periods: 45

TEXT BOOKS

1. Van Valkenburg, "Network Analysis", Prentice Hall of India, 3rd Edition, New Delhi, 2015.
2. Ravish R. Singh, "Network Analysis and Synthesis", McGraw-Hill Education, 2nd Edition, 2019.

REFERENCES

1. Chakrabati A, "Circuits Theory (Analysis and Synthesis)", Dhanpath Rai & Sons, New Delhi, 7th Revised Edition, 2018.
2. John Bird, "Electrical Circuit Theory and Technology", 5th Edition, Routledge Publication, 2013.
3. Sudhakar A. and Shyammohan, "Circuits and Networks Analysis and Synthesis", Tata McGraw Hill Publishing Co. Ltd., 5th Edition, New Delhi, 2017.
4. Suresh Kumar K.S., "Electric Circuits and Networks", Pearson Education, 2009.
5. Van Valkenburg, "Introduction to Modern Network Synthesis", Wiley Eastern Limited, 1999.

ONLINE REFERENCE

1. https://onlinecourses.nptel.ac.in/noc21_ee14/preview
2. https://www.sciencedirect.com/science/article/pii/S1877705814023601
3. https://onlinelibrary.wiley.com/doi/abs/10.1002/wat2.1296
4. https://dspace.vutbr.cz/xmlui/handle/11012/37052

CASE STUDY

1. Optimal approach of water system operation using graph theory algorithm.
2. Graph theory based approach for understanding braided river morpho dynamics.
3. Role of active power filters in power system applications.
4. Design of two port network transfer function for power line topology modeling.

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE203 ELECTROMAGNETICS 2 1 0 3

PREREQUISITES

20PH205 -Applied Physics

20MA203 -Integral and Vector Calculus

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the concepts of Electrostatics and applications.	PO1, PO2, PO5, PO12
CO2:	Understand the concepts of Magnetostatics and applications.	PO1, PO2, PO5
CO3:	Applying Divergence and Stoke's theorem and basic laws of EMF to explain Maxwell's equations.	PO1, PO2, PO5
CO4:	Explain Electrodynamic Fields and wave propagation.	PO1, PO2, PO5
CO5:	Design and simulate Electromagnetic Elements and Energy storage devices.	PO1, PO2, PO5, PO12

ELECTROSTATIC FIELD AND APPLICATIONS **15**

Review of Vector Calculus: Coordinate systems, Coordinate transformation, Gradient of scalar fields, Divergence and Curl of vector fields. Divergence theorem - Stoke's theorem - Coulomb's law - Electric field intensity - Electric fields due to point, line, surface and volume charge distributions - Electric flux density - Gauss law - Electric potential - Potential gradient - Poisson's and Laplace equations - Field due to dipoles - Dipole moment -Polarization - Conductors and Dielectrics - Boundary conditions - Capacitance -Dielectric strength - Energy stored in capacitor - Energy density.

MAGNETOSTATIC FIELD AND APPLICATIONS **15**

Introduction - Lorentz force - Biot Savart's Law - Ampere's Circuital Law - Applications - Magnetic flux - Magnetic flux density - Scalar and Vector magnetic potentials - Force on a moving charge and current elements - Force and Torque on closed circuit - Introduction to magnetic materials - Magnetization and Permeability - Magnetic boundary conditions - Magnetic circuit - Faraday's Law - Self Inductance and mutual inductance - Inductance of solenoids, toroids and transmission lines -Electromagnetic actuators- Relation between field theory and circuit theory.

ELECTRODYNAMIC FIELD AND WAVE PROPAGATION **15**

Conduction current and Displacement current - Maxwell's equation in point and integral forms - Wave equations - Wave propagation in free space - Wave propagation in Dielectrics - Propagation in good conductors - Poynting Theorem and Poynting Vector - Skin depth - Wave polarization - Plane wave reflection and refraction-Cell phone Antennas, WiFi Communication, Wireless Technologies- Effects of electromagnetic waves.

Total Periods: 45

TEXT BOOKS

1. William H.Hayt, Jr. John A. Buck, "Engineering Electromagnetics", 8th Edition, McGraw Hill, 2012.
2. K.A. Gangadhar and P. M. Ramanathan, "Electromagnetic Field theory", New 5th Edition,Khanna Publishers, 2013.

REFERENCES

1. Joseph A. Edminister, "Theory and Problems of Electromagnetics", Schaum Series, 2nd Edition, McGraw Hill, 2006.
2. Mathew N. O. Sadiku, "Elements of Electromagnetics", 4th Edition, Oxford University Press, 2006.
3. John D. Kraus, "Electromagnetics", 5th Edition, McGraw Hill, 1999.
4. Kraus and Fleish, "Electromagnetics with Applications", 5th Edition, McGraw Hill International Editions, 1999.
5. David K Cheng, "Field and Wave Electromagnetics", 2nd Edition, Pearson Education, 2004.

WEB REFERENCES

1. http://nptel.ac.in/courses/108101090

CASE STUDY

Simulation study using MATLAB and Ansys Maxwell simulation software

1. 3-D and 2-D analysis in electromagnetic devices.
2. Vector analysis
3. Coordinate system
4. Electric and Magnetic dipole
5. Static and Time-varying electromagnetic and electric fields

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE238 ELECTRICAL MACHINES AND POWER SYSTEMS 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Understand the principles of operation and performance analysis of DC machines and transformers.	PO1,PO2
CO2:	Outline the construction and operation of induction, synchronous and few special machines.	PO1,PO2
CO3:	Comprehend the power generation, transmission and distribution systems.	PO1,PO2,PO6
CO4:	Compare EHVAC and EHVDC Systems and Understand the types of substation.	PO1,PO2,PO6

D.C. MACHINES AND TRANSFORMERS **18**

DC GENERATOR - operation - EMF equation - Methods of excitation - Self and separately excited generators - Characteristics of series and shunt generators -Principle of operation of D.C. Motor -Back emf and torque equation - Characteristics of series and shunt motors - Starting of D.C. Motors -Types of starters - Speed control and braking of DC motors.

TRANSFORMERS - Principle of Operation -EMF Equation -Transformation Ratio -Transformer on No Load -- Transformer on Load -Equivalent Circuit -Regulation - Testing -Polarity and ratio test- open circuit and short circuit test - Three phase transformers connections.

AC MACHINES AND SPECIAL MACHINES **18**

Induction Machines: Types -Principle of operation of three-phase induction motors - Speed-Torque characteristics - Starting and speed control -Single-phase induction motors.

Synchronous machines - Types -Induced emf - Brushless alternators -Reluctance motor - Stepper motor - Servo motor - BLDC Motor.

INTRODUCTION TO POWER SYSTEMS **9**

Structure of electric power systems -Generation, transmission, sub-transmission and distribution systems - EHVAC and EHVDC transmission systems -Substation layout.

Total Hours: 45

TEXT BOOKS

1. Gupta J.B., "Theory and Performance of Electrical Machines", 14th Edition, S.K.Kataria and Sons, 2009.
2. Kothari D.P. and Nagrath I.J., "Electric Machines", 3rd Edition, Tata McGraw Hill Publishing Company Ltd, 2004.
3. Mehta V.K. and Rohit Mehta, "Principles of Power System", 3rd Edition, S.Chand and Company Ltd, 2006.

REFERENCES

1. Fitzgerald A.E., Charles Kingsley, Stephen D. Umans, "Electric Machinery", 6th Edition, McGraw Hill publishing Company Ltd, 2003.
2. Bhattacharya S. K., "Basic Electrical and Electronics Engineering", 1st Edition, Pearson Education, 2011.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/105/108105017/7/
2. http://nptel.ac.in/courses/108105017
3. http://nptel.ac.in/courses/108106072
4. http://nptel.ac.in/courses/108102047

CASE STUDY

1. Applications of Induction Motors in Electric Vehicles.
2. Applications of DC Motors in Electric Vehicles.
3. Effects of Corona in transmission line.
4. Transformer Failure Analyses.

20EC201 ELECTRON DEVICES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Interpret and describe the concepts of semiconductor devices.	PO1
CO2:	Apply the electronic fundamental concepts and determine the device characteristics.	PO1, PO2
CO3:	Examine the device performance of Semiconductor diodes and transistors.	PO1, PO2, PO5
CO4:	Design transistor amplifier circuit for different biasing techniques, clipper & clamper circuits.	PO1, PO3, PO5

SEMICONDUCTOR DIODES **15**

Electrons and Holes in Silicon: Energy band diagram, n-Type and p-Type silicon - Carrier Transport in Silicon - Basic Equation for Device Operation

PN Junction: Energy-Band diagrams for a p-n diode - Abrupt junction - Charge densities in semiconductors - Mobility and Conductivity - Drift and Diffusion current - The diode equation - Current - Voltage Characteristics - Time dependent and Switching Characteristics - Diffusion Capacitance - Applications - Clipper and clamper circuits - Voltage multipliers - Rectifiers.

Zener diode: Characteristics and applications - Voltage regulators - DC regulated Power Supply - SMPS.

BIPOLAR JUNCTION TRANSISTOR **10**

Basic concepts - Configurations - Loadline and Quiescent Point - Biasing Circuits - Stability Factor - Small Signal Analysis: Low Frequency h-parameter model - Determination of h-parameters from characteristics - Mid-band analysis of a BJT single stage amplifiers - Analysis using simplified hybrid model.

FIELD EFFECT TRANSISTORS **10**

JFET: Basic concepts, Device Characteristics: Transconductance - Pinch off Voltage - Biasing circuits - Small signal equivalent circuits.

MOSFET: Characteristics - Threshold voltage - channel length modulation - DMOSFET - EMOSFET - Characteristics - Comparison of MOSFET with JFET.

SPECIAL SEMICONDUCTOR DEVICES **10**

Homogeneous and Heterogeneous junction in Semiconductor - UJT - Avalanche Photodiode - Tunnel diode - Varactor diode - MESFETs - TFETs - HEMTs - Silicon Nanowire transistors - Power BJT - Power MOSFET - Solar cell - CCD - Opto-coupler devices.

Total Hours:45

TEXT BOOKS

1. Robert. L.Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", PearsonEducation, India, 11th Edition, 2015.
2. Donald.A. Neamen, "Semiconductor Physics and Devices", McGraw Hill Education India Pvt Ltd, 4thEdition, New Delhi, 2007.

REFERENCES

1. Jacob Millman, Christos C.Halkias, "Electronic Devices and Circuits", Tata McGraw HillPublishing Limited, New Delhi, 4th Edition, 2015.
2. Thomas L. Floyd, "Electronic Devices:Conventional current version", Pearson Education, India, 9th Edition, 2015.
3. Salivahanan.S, Suresh Kumar.N, "Electronic Devices and Circuits", 4th Edition,Tata McGraw Hill Publishing Limited, 2018.
4. Simon M.Sze and Kwok K.Ng, "Physics of Semiconductor Devices", 3rd Edition, John Wiley &Sons,2007.

WEB REFERENCES

1. https://nptel.ac.in/courses/122/106/122106025/
2. https://nptel.ac.in/courses/117/103/117103063/
3. https://nptel.ac.in/courses/117/106/117106089/

ENLIGHTENMENT THROUGH EDUCATION SREC

20EC202 AIRCRAFT ELECTRICAL AND ELECTRONIC SYSTEMS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Interpret the fundamental concepts of Electrical and Electronic circuits and the working of AC and DC machines.	PO1
CO2:	Apply the electrical, electronic fundamentals and laws to solve simple circuits.	PO1, PO2
CO3:	Develop a program to interface different sensors with Arduino board using Arduino IDE.	PO1, PO2, PO5
CO4:	Design the simple combinational and sequential digital logic circuits.	PO1, PO3, PO5

FUNDAMENTAL ELECTRICAL AND ELECTRONIC PRINCIPLES 9

Electrical fundamentals: Electron theory, Electrostatics and Capacitors - Current, Voltage and Resistance - Power and Energy- Electric circuit laws - Electromagnetism and inductors- Alternating current and transformers - Safety - Electronic fundamentals: Semiconductor theory - Diodes - Half wave and Full wave rectifier - Voltage regulator - Transistors - Transistor as a switch and amplifier - Integrated Circuits.

DC AND AC MACHINES 6

Generators and Motors: Generator and motor principles - DC generator and DC motor - AC generator and AC motor - Three-phase generation and distribution - Practical aircraft generating systems.

POWER SUPPLIES AND CIRCUIT PROTECTION 8

Power supplies: Regulators - External power - Inverters - Transformer rectifier units - Transformers - Auxiliary power unit - Emergency power - Distribution of power supplies: Single engine/general aviation - Twin engine general aviation aircraft - Larger aircraft systems - Control and protection - Load shedding- Wiring and circuit protection.

CONTROLS AND TRANSDUCERS 6

Switches - Relays and contactors - Variable resistors - Linear displacement transducers - Fluid pressure transducers - Temperature transducers - Strain transducers - Rotary position transducers.

DIGITAL ELECTRONICS 10

Boolean Algebra Theorems - De Morgan's theorem - Logic Gates - Design procedure of simple combinational and sequential logic circuits.

INTERFACING WITH ARDUINO 6

Arduino IDE - Programs using Arduino - Interfacing Arduino with Sensors: Pressure, Temperature, Speed - Bluetooth and Ethernet.

Total Hours: 45

TEXT BOOKS

1. Mike Tooley and David Wyatt, "Aircraft Electrical and Electronic Systems", 2nd Edition, Routledge Publishers, 2018.

2. Morris Mano M,Micheal D. Ciletti, "Digital Design", 6th Edition, Pearson Education, 2018.

3. Simon Monk, "Programming Arduino: Getting Started with Sketches", McGraw-Hill Education TAB; 2nd Edition, 2016.

REFERENCES

1. Scott Kenney, "Fundamentals of Aircraft Electronics", 1st Edition, Avotek Information Resources, 2013.

2. Avotek, "Aircraft Wiring and Electrical Installation", 1st Edition, Avotek Information Resources, 2005.

3. Thomas K.Eismin, "Aircraft Electricity and Electronics Systems", 6th Edition, McGraw Hill Education, 2014.

WEB REFERENCES

1. https://nptel.ac.in/courses/101/104/101104071

2. https://swayam.gov.in/nd1_noc20_ae03/

ENLIGHTENMENT THROUGH EDUCATION SREC

20EC270 BASIC ELECTRICAL AND ELECTRONICS LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Apply the fundamental laws and theorems and determine the characteristics of the electrical, electronic circuits and machines.	PO1
CO2:	Design and implement the basic combinational and sequential logic circuits.	PO1, PO3
CO3:	Simulate and examine the response of digital logic circuit applications.	PO1, PO2, PO5
CO4:	Develop programs to interface various sensors with Arduino board and obtain theresults.	PO1, PO2, PO5

List of Experiments

1. Measurement of passive circuit components - resistance, inductance and capacitance.
2. Verification of Ohm's Law to determine the value of an unknown resistance.
3. Verification of Kirchhoff's Law.
4. Load test and computing residual voltage of DC generator.
5. Load test on DC Shunt motor.
6. BJT, JFET, MOSFET as an amplifier.
7. Characteristics of diodes - Applications as half wave and full wave rectifier.
8. Implementation of basic combinational and sequential logic circuit.
9. Simulation of digital logic circuit applications
    a. Landing gear warning logic
    b. Auxiliary Power Unit starter logic
10. Programming using Arduino
    a. Interfacing Temperature sensor, Ultrasonic sensor, PIR sensor
    b. Interfacing Accelerometer and Gyroscope

20EC222 ANALOG DEVICES AND INTEGRATED CIRCUITS 3 0 0 3

PREREQUISITEs

1. 20EE201 - Electric Circuits
2. 20EC201- Electron Devices

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Analyse the biasing methods of JFET, high frequency model of BJT and JFET.	PO1,PO2,PO5
CO2:	Illustrate the concepts of Power and Feedback amplifiers	PO1,PO2,PO5
CO3:	Analyse the various types of tuned amplifiers and determine the frequency of oscillation for oscillators	PO1,PO2,PO3,PO5
CO4:	Explain the basic concepts of operational amplifier and infer its DC and AC characteristics.	PO1,PO2
CO5:	Design the linear and nonlinear applications of operational amplifiers	PO1,PO2,PO5
CO6:	Illustrate the functions of DAC, ADC and special function ICs	PO1,PO2,PO3

PRINCIPLES OF BIASING, POWER AND FEEDBACK AMPLIFIERS **15**

FET amplifiers - Biasing of JFET - Small signal analysis of JFET amplifiers at low frequencies - Miller theorem - Introduction to Power Amplifiers and its types (Class A, Class B, Class C, Class D) - Feedback amplifiers - Classification of feedback amplifiers.

TUNED AMPLIFIERS AND OSCILLATORS **10**

Analysis of Single tuned, double tuned and staggers tuned amplifiers - stabilization techniques.

Barkhausen Criteria - Design and analysis of RC (RC Phase Shift and Wien Bridge) and LC (Hartley and Colpitt) Oscillators - Crystal Oscillator.

OP-AMP AND ITS APPLICATIONS **10**

Basics of Operational Amplifier - Open and Closed Loop characteristics - Inverting and Non - Inverting, and Voltage Follower - DC and AC Characteristics of Op. Amplifier - Applications of Operational Amplifier: Instrumentation Amplifier - Comparators - Active Filters: First order LPF, HPF, BPF, BSF.

DATA CONVERTERS AND SPECIAL FUNCTION IC's **10**

Performance Characteristics of ADC and DAC - Weighted Resistor DAC, R-2R Ladder type DAC - Successive approximation ADC.

Voltage controlled Oscillator (IC566), Phase Locked Loop (IC565) - Introduction to IC555 timer - Multivibrators using IC555 timer - IC723 General Purpose Regulator.

Total Hours: 45

TEXT BOOKS

1. Millman J and Halkias C, "Electronic Devices and Circuits", 3rd Edition, Tata McGraw Hill, 2010.
2. David.A.Bell, "Electronic Devices and Circuits", 5th Edition, Prentice Hall of India, 2010.
3. Millman J and Halkias C, "Integrated Electronics", 2nd Edition, Tata McGraw Hill, 2010.
4. Roy Choudhry.D and Shail B.Jain, "Linear Integrated Circuits", 5th Edition, New Age International Pvt. Ltd., 2018.

REFERENCES

1. Schilling and Belove, "Electronic Circuits", 3rd Edition, Tata McGraw Hill, 2008.
2. Millman J. and Taub H., "Pulse Digital and Switching Waveform", 3rd Edition, Tata McGraw Hill International, 2011.
3. Anil K. Maini and Varsha Agrawal, "Electronic Devices and Circuits", 1st Edition, Wiley India Pvt. Ltd, 2016.
4. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata McGraw -Hill Education Pvt. Ltd., 2008.
5. William D. Stanely, "Operational Amplifiers with Linear Integrated Circuits", 4th Edition, Pearson Education, 2009.

WEB REFERENCES

1. Analog Circuits - http://nptel.ac.in/courses/117101106/
2. Analog ICs - http://nptel.ac.in/courses/108106068/

ENLIGHTENMENT THROUGH EDUCATION SREC

20EC290 ANALOG DEVICES AND INTEGRATED CIRCUITS LABORATORY 0 0 2 1

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Analyze JFET with voltage divider biasing method	PO1,PO2,PO4,PO5,PO9
CO2:	Determine the frequency response of power, feedback and tuned amplifiers.	PO1,PO2,PO3, PO4,PO5,PO9
CO3:	Design and Construct low frequency oscillators.	PO1,PO2,PO3, PO4,PO5,PO9
CO4:	Design and construct various applications of operational amplifiers and IC555 timer.	PO1,PO2,PO4 PO5,PO9
CO5:	Construct electronic circuits using simulation software.	PO1,PO2,PO4,PO5,PO9
CO6:	Communicate the results of the experiments through reports.	PO9,PO10,PO12

List of Experiments

1. Biasing of JFET using voltage divider method.
2. Frequency response of power amplifier and feedback amplifier.
3. Frequency response of tuned amplifier.
4. Low frequency oscillator.
5. Inverting, Non - Inverting and Voltage Follower.
6. Wave Shaping Circuits using IC741.
7. R-2R type DAC.
8. Design of 2nd order active filters.
9. Multivibrators using IC555 timer.
10. Simulation experiments using Software.

20EC223 DIGITAL CIRCUITS AND MICROCONTROLLERS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Simplify the Boolean expressions.	PO1
CO2:	Design the combinational and sequential logic circuits.	PO1, PO3,PO4,PO5, PO11
CO3:	Summarize the concepts of data converters and semiconductor memories	PO1
CO4:	Explain the internal architecture, addressing modes and the instruction sets of 8051.	PO1
CO5:	Explain the ARM programming model and its processor architecture.	PO1, PO3,PO5, PO11

DIGITAL LOGIC CIRCUITS **18**

Review of number systems - Boolean algebra - Minimization of Boolean expressions - Digital logic gates - Gate level minimization -Combinational logic circuits: Decoders - Encoders - Multiplexers - Demultiplexers - Code converters -PLAs -Sequential Logic Circuits: Latches - Flip-flops - Shift registers-Counters - Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM

8051 MICROCONTROLLER **12**

8051 Microcontroller Hardware - Input/output Ports and circuits - Counters and Timers -Serial Data Input/output - Interrupts - 8051 interfacing to external memory 8051 - Addressing Modes and Instruction set -assembly language programming

8051 C PROGRAMMING **9**

Data types and time delay - I/O Programming - Logic operations-On chip peripheral 8051 programming: Timer/Counter - Serial port - Interrupts.

THE ARM RISC ARCHITECTURE **6**

The ARM programmer's model - 3 stage and 5 stage pipeline ARM organization - ARM processor cores - ARM7 TDMI, ARM9TDMI - ARM Development Tools.

Total Hours: 45

TEXT BOOKS

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson Education, 2012.
2. Kenneth Ayala, "The Microcontroller Architecture - Programming and Applications", 3rd Edition, Cengage Learning, 2004.
3. Steve Furber, "ARM System-on - chip-architecture", 2nd Edition, Pearson Education, 2007.

REFERENCES

1. Alan B.Marcovitz, "Introduction to Logic Design", 2nd Edition, Tata McGraw-Hill, 2005.
2. Mohammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", 2014, Pearson, India.
3. Andrew Sloss, "ARM System Developer's Guide: Designing and Optimizing System Software", 1st Edition, Morgan Kaufmann, 2005.

WEB REFERENCES

1. http://nptel.ac.in/courses/117106086/
2. https://nptel.ac.in/courses/108/105/108105102/

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Design and Implement combinational and sequential logic circuits using gates.	PO1,PO2,P04, PO5,PO9
CO2:	Develop embedded C program for 8051 on chip peripherals.	PO2,P04,PO5,PO9,PO11
CO3:	Develop interfacing programs for 8051 microcontroller using Embedded C.	PO2,P04,PO5,PO9,PO11, PO12S
CO4:	Develop real time interfacing programs for ARM controller in Embedded C.	PO2,P04,PO5,PO9,PO11, PO12
CO5:	Communicate the results of the experiments through reports.	PO9, PO10, PO12

List of Experiments

DIGITAL LOGIC CIRCUITS

1. Design and implementation of combinational logic circuits.
2. Design and implementation of sequential circuits.

8051 MICROCONTROLLER BASED EMBEDDED C PROGRAMS

3. I/O port programming.
4. On chip 8051 Timer programming.
5. On chip 8051 Serial port programming.
6. Interfacing of LCD and Motors with 8051 microcontroller.

EMBEDDED C PROGRAMMING USING LPC2148 ARM MICROCONTROLLER

7. Study of LPC2148 ARM Microcontroller.
8. Developing Embedded C Applications for programming GPIO Ports.

WEB REFERENCES

1. LPC 2148 USER MANUAL
2. http://www.ocfreaks.com/lpc2148-gpio-programming-tutorial/

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Interpret the principles of Boolean algebra to manipulate and minimize logic expressions	PO1, PO2, PO3, PO5, PO12
CO2:	Design the combinational logic circuits	PO1, PO2, PO3, PO5, PO12
CO3:	Construct finite state machines using sequential circuits	PO1, PO2, PO3, PO5, PO12
CO4:	Implement the combinational circuits using programmable logic devices and HDL	PO1, PO2, PO3, PO5, PO12
CO5:	Design and implement logic circuits	PO1, PO2, PO3, PO5, PO12
CO6:	Communicate the results of the experiments through reports.	PO9, PO10, PO12

FUNDAMENTALS OF DIGITAL SYSTEMS **5**

The Digital Abstraction -Number System and Codes - Boolean algebra and logic gates - From Logic to Gates - Simplification of Switching Functions - The Karnaugh Map Method - Quine-McCluskey Technique

COMBINATIONAL LOGIC CIRCUITS **6**

Analysis of combinational logic circuits - Arithmetic Circuits - Decoders / Encoders - Multiplexers / Demultiplexers -Code converters -Applications of combinational logic circuits

SEQUENTIAL LOGIC CIRCUITS **13**

Models for Sequential logic circuits -Flip-flops - Analysis of clocked synchronous sequential circuits -Mealy and Moore machines - Finite state machine - State minimization/reduction, state assignment - Applications - Counters - Registers - Types of Asynchronous logic circuits -Analysis and Synthesis of Fundamental mode Asynchronous logic circuits -Cycles -Races -Hazards

MEMORY, PROGRAMMABLE LOGIC DEVICES AND HDL **6**

Memory: RAM architecture, Types of RAM & ROM architecture, Types of ROM, Programmable logic devices: Concepts of PLA, PAL, FPGA -Implementation of combinational logic using PLA and PAL, HDL: Preface to Verilog programming - Realization of combinational and sequential circuits using HDL

CASE STUDY:

Systematic design approach for Leap Year Calculation, Digital Combination Lock

LABORATORY EXPERIMENTS

- Design and Implementation of combinational and sequential logic circuits
- Design of Mealy and Moore models of state machines
- Simulation of combinational and sequential circuits using HDL
- Design and implementation of a digital system

Total Hours: 45

TEXT BOOKS:

1. Morris Mano, "Digital Design", 6th Edition, Pearson Education Ltd., 2018.
2. Randy H. Katz, Gaetano Borriello, "Contemporary Logic Design", 2nd Edition, Prentice Hall, 2005.
3 Samir Palnitkar, "Verilog HDL", 2nd Edition, Pearson Education, 2003.

REFERENCE BOOKS

1. Ronald J. Tocci, "Digital Systems: Principles and Applications", Pearson Education, 10th Edition, 2009
2. Charles H.Roth, "Fundamentals of Logic design", 7th Edition, Thomson Learning, 2014.
3. Victor P. Nelson, H. Troy Nagle, J. David Irvin, Bill D. Carol, "Digital logic Analysis and design", 1st edition, Prentice Hall Publications, 1995.
4. S. Brown and Z. Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata Mc-Graw Hill, 2008.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee10
2. https://onlinecourses.nptel.ac.in/noc21_ee39

ENLIGHTENMENT THROUGH EDUCATION SREC

20EC252 MICROCONTROLLERS AND PROGRAMMING 2 0 2 3

PREREQUISITE

20EC251 - Digital Logic Circuits

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Illustrate the internal architecture, addressing modes and the instruction sets of 8051.	PO1, PO9, PO10, PO11, PO12
CO2:	Develop embedded C programme for on chip/external peripherals of 8051/P89C66x microcontroller and simple ALP.	PO1, PO3, PO4, PO5, PO9, PO10, PO11, PO12
CO3:	Describe ARM programming model and ARM instructions.	PO1, PO9, PO10, PO11, PO12
CO4:	Develop embedded C programme for LPC2148 microcontroller.	PO1, PO3, PO4, PO5, PO9, PO10, PO11, PO12
CO5:	Communicate the results of the experiments through reports.	PO9, PO10, PO12

THE 8051 ARCHITECTURE, INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING 8

8051 Microcontroller Hardware - Input/output Ports and circuits - Counters and Timers -Serial Data Input/output - Interrupts. 8051 interfacing to external memory 8051 Addressing Modes and Instruction set - assembly language programming.

8051 C PROGRAMMING 7

Data types and time delay - I/O Programming - Logic operations -On chip peripheral 8051 programming : Timer/Counter - Serial port - Interrupts.

Introduction of P89C66x - Programmable counter array (PCA) - PWM - Integrated circuit (IIC or I2C).

THE ARM RISC ARCHITECTURE & ARM INSTRUCTIONS 10

The ARM programmer's model - ARM processor core - ARM7 TDMI, Exceptions - Conditional execution - Branch and branch with link and exchange - Software interrupt - Data processing instructions - Single word and unsigned byte data transfer instructions - Half word and signed byte data transfer instructions - Multiple register transfer instructions - Swap instructions - The thumb instruction set -simple Assembly Language programming

LPC2148 ARM CPU AND C PROGRAMMING 5

LPC 2148- Salient features, block diagram, Programming: GPIO, Timer.

Laboratory Experiments

1. 8051 Assembly Programming for various addressing modes
2. 8051 C programming for Timer
3. 8051 C programming for Port handling operations
4. 8051 C programming for interfacing actuators and sensors

5. ARM7 programming on basic electronic components like LED, LCD, Buzzer, Switch, Keypad interfacing
6. ARM7 programming for GPIO operations
7. ARM7 programming for Timer controlling operations

Total Hours: 45

TEXT BOOKS

1. Kenneth Ayala, "The Microcontroller Architecture - Programming and Applications", 3rd Edition, Cengage Learning, 2007.
2. Steve Furber, "ARM System-on - chip-architecture", 2nd Edition, Pearson Education, 2015.
3. David Calcutt, Frederick Cowan, Hassan Parchizadeh, "8051 Microcontroller: An Applications Based Introduction", Newnes (An imprint of Elsevier), 2003.

REFERENCES

1. Muhammad Ali Mazidi, Jamice GillispitMazidi, "The 8051 micro controller and Embedded System", 2nd Edition, Pearson Education 2011.
2. Andrew Sloss, "ARM System Developer's Guide: Designing and Optimizing System Software", 1nd Edition, Morgan Kaufmann, 2005.
3. William Hohl, "ARM Assembly Language" -, CRC Press, Second Edition 2015
4. LPC 2148 USER MANUAL
5. P89C66x data sheet --Philips Semiconductors

WEB REFERENCE

1. https://nptel.ac.in/courses/108/105/108105102/
2. www.ocfreaks.com

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

20EI201 ELEMENTS OF INSTRUMENTATION 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Recall the concepts of measurement system with statistical analysis.	PO1
CO2:	Outline the operating principles of Analog Instruments.	PO1
CO3:	Illustrate the principles of operation of digital instruments and display devices.	PO1
CO4:	Select an appropriatebridge circuits to measure the unknown resistance and impedance.	PO1

MEASUREMENT AND INSTRUMENTATION **08**

Significance of measurement - Instrument systems and its Classification - Classification of instruments - Analog and digital modes of operations - Applications of measurement systems - Errors-Statistical analysis of error - Units and standards of measurement - Calibration techniques.

MEASURING INSTRUMENTS **12**

Analog instruments: Classification, principles of operation, operating forces- Galvanometers: D'Arsonval Galvanometer, Vibration galvanometer- Analog ammeters and voltmeters- Permanent Magnet Moving Coil, Moving Iron, Electrodynamometer type instrument.

Digital Instruments: Digital voltmeter, Digital frequency meter, Digital multimeter - Display devices: Cathode Ray Oscilloscope - Digital Storage Oscilloscope.

MEASUREMENT OF RESISTANCE AND IMPEDANCE **10**

Measurement of Resistance: DC Bridges: Wheatstone's bridge, Kelvin Bridge

Measurement of Impedance: AC bridges: Anderson bridge, Maxwell's Impedance bridge, Hay's bridge Schering bridge, De Sauty's bridge.

Total Hours: 30

CASE STUDIES

1. Real time data acquisition of pulses in pulse oximeter using Digital Storage Oscilloscope.
2. Design of signal conditioning unit for the measurement of room temperature using resistivity principle under bridge balanced condition.
3. Identify the elements in analog instruments and prepare a document.

TEXT BOOKS

1. A.K.Sawhney "A Course in Electrical and Electronic Measurements and Instrumentation", 19th Edition, Dhanpat Rai & Co. (P) Ltd, 2019.
2. David A. Bell, "Electronic Instrumentation and Measurements", 3rd Edition, Oxford University Press India, 2013.

REFERENCES

1. Hermann K.P. Neubert, "Instrument Transducer", 2nd Edition, Oxford University press, 2015.
2. H.S.Kalsi, "Electronic Instrumentation and Measurements", 4th Edition, McGraw-Hill publications, 2019.
3. Murthy D.V.S, "Transducers and Instrumentation", 2nd Edition, Elsevier publications, 2010.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://swayam.gov.in/nd1_noc19_ee44/preview
3. https://nptel.ac.in/courses/112/107/112107242/

20EI202 SENSORS AND ITS APPLICATIONS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Recall the principle of sensing mechanism and its thermal properties.	PO1
CO2:	Outline the concepts of IoT and its applications	PO1
CO3:	Explain the data collection and processing for data analytics.	PO1
CO4:	Identify the suitable sensor for appropriate applications	PO1

SENSING TECHNIQUES **08**

Sensors- Classification of sensors- Physical principle of sensing: Resistance, Inductance, Capacitance, Magnetism, Piezoelectric effect, Pyroelectric effect, Thermoelectric effect, Thermal properties of materials.

SENSORS AND DATA ANALYTICS **14**

IoT architecture - IoT standards- Connectivity challenges in IoT implementation- Applications: Intelligent traffic system- Smart parking System

Data collection: Model driven data acquisition, Data driven data acquisition- Data Processing: Enabling complex analytics, Detection and tracking.

APPLICATIONS **08**

Sensors for Environmental Monitoring-Sensors for Smart Phone-Sensors for Automotive Applications- Sensors for Healthcare Applications.

Case studies

1. Implementation of IoT for smart cargo handling.
2. Acquisition of mobile sensor data through mobile application.

Total Hours: 30

TEXT BOOKS

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", 4th Edition, Springer Science and business media, 2010.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", 19th Edition, DhanpatRai& Co. (P) Ltd, 2019.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1st Edition, CRC Press,2017.

REFERENCES

1. Hermann K.P. Neubert, "Instrument Transducer", 2nd Edition, Oxford University press, 2015.
2. Raj Kamal, "Internet of Things",1st Edition, McGraw Hill Education, 2017.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://nptel.ac.in/courses/108/108/108108123/

20EI203 AEROSPACE SENSORS AND INSTRUMENTATION 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Recall the concepts of measurement system with statistical analysis.	PO1
CO2	Classify the sensors for the measurement of various physical parameters.	PO1
CO3	Identify an appropriate sensor for the measurement of motion and inertia.	PO1
CO4	Outline the concepts of IoT and its applications	PO1

MEASUREMENTS AND INSTRUMENTATION **05**

Significance of measurement-Classification of Instruments- Characteristics of measuring systems - Errors- Calibration- Statistical analysis of error.

SELECTION OF SENSORS **10**

Sensors - Classification of sensors - Pressure Measurement: Manometer, Pressure transducers, Temperature Measurement: Thermometers, Thermocouples- Velocity Measurement: Pitot probes, Laser Doppler Velocimetry (LDV), Particle Image Velocimetry (PIV), Deflecting vane anemometers - Capacitive Proximity sensors.

Vibration instruments, Principles of seismic instrument, Practical considerations for seismic instruments, Sound measurements.

MOTION AND INERTIAL MEASUREMENTS **08**

Applications of accelerometer sensors, Pendulous accelerometer (open and closed loop), Piezoelectric accelerometer, Gyroscope principles, Micro-gyro sensors, Laser gyros.

IoT SENSORS and DEVICES **07**

IoT architecture - IoT standards- Connectivity challenges in IoT implementation- Applications: Intelligent traffic system- Smart parking system.

Total Hours: 30

TEXT BOOKS

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications" 4th Edition, Springer science and business media, 2010.
2. A.K.Sawhney "A Course in Electrical and Electronic Measurements and Instrumentation", 19th Edition, Dhanpat Rai & Co. (P) Ltd, Delhi, 2019.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1th Edition, CRC Press, 2017.

REFERENCES

1. Hermann K.P. Neubert, "Instrument Transducer", 2th Edition, Oxford University press, 2015
2. Raj Kamal, "Internet of Things",1th Edition, McGraw Hill Education, 2017.

WEB REFERENCES

1. https://www.classcentral.com/course/swayam-mechanical-measurement-systems-10084
2. https://nptel.ac.in/courses/108/108/108108147/
3. https://nptel.ac.in/courses/108/108/108108123/

20EI204 ELECTRIC CIRCUITS AND ELECTRONIC DEVICES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Solve the DC Circuits using network theorems	PO1, PO2
CO2	Analyze the transient response of series and parallel AC circuits	PO1, PO2
CO3	Outline the device characteristics and its applications	PO1, PO2
CO4	Summarize the characteristics and applications of special devices	PO1, PO2

DC CIRCUIT ANALYSIS **09**

Charge, current, voltage, power and energy- Ideal voltage and current sources - Independent sources- Dependent sources- Circuits elements - Voltage and current division in series and parallel circuits - Network analysis using Mesh and nodal analysis - Source transformation- Star delta transformation- Circuit theorems: Thevenin, Norton, Superposition, Reciprocity and Maximum Power transfer theorem.

AC CIRCUIT ANALYSIS **12**

Sinusoidal voltage and current- RMS value- Form factor -Phasor representation of sinusoidal voltage-Current, Voltage- Current relationship in R,L and C Circuits-Impedance and admittance- Power factor concepts in RL and RC circuits- RLC Circuits-Impedance combination- Real power-Reactive power, complex power, apparent power-Analysis of simple series and parallel circuits, concepts of three phase circuits - Introduction to resonance circuits.

DEVICE CHARACTERISTICS AND APPLICATIONS **12**

Diodes - Characteristics, design of regulated power supply- BJT: Characteristics and h-parameters for CE and CB configurations - Oscillators- Transistor as a switch - Transistor as an amplifier-Tristate Buffer.

SPECIAL DEVICES CHARACTERISTICS AND APPLICATIONS **12**

Characteristics and application: UJT, Zener- Voltage Regulator SCR, DIAC, TRIAC, JFET, MOSFET, IGBT, LED, LCD, Optocoupler.

Case Studies:

1. Verification of Theorems using simulation tool
2. Design of Transistor Based Switch Circuit using simulation tool
3. Design of Switched Mode Power Supply using simulation tool

Total Hours: 45

TEXT BOOKS

1. John Bird, "Electric Circuit Theory and Technology", 4th Edition, Newnes Publication, 2010.
2. Robert. L. Boylestad, Louis Nashalskey, "Electronic Devices and Circuits", 11th Edition, Pearson Education, 2015.

REFERENCES

1. Joseph A.Edminister, MahmoodNahri, "Electric Circuits", 5th Edition, McGrawHill Education Pvt.,Ltd, 2010.
2. William H.Hayt, Jack E.Kemmerly and Steven M.Durbin, "Engineering Circuit Analysis", 8th Edition, McGrawHill Education Pvt.,Ltd, 2013.
3. Charles. K. Alexander, Mathew. N.O.Sadiku, "Fundamentals of Electric Circuits", 5th Edition, McGraw Hill Education Pvt.,Ltd, 2013.
4. Salivahanan.S, Suresh Kumar.N and Vallavaraj.A, "Electronic Devices and Circuits", 3rd Edition, McGraw Hill Education Pvt.,Ltd, 2012.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc17-ee02/preview
2. www.vidyathiplus.in/2011/11electronic-device-and-circuits-edc.html/
3. nptel.ac.in/courses/117106108

PREREQUISITE: 20PH205 - Applied Physics

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Recall the concepts of measurement system with statistical analysis	PO1
CO2:	Recognise the principles of sensing mechanisms and its thermal properties	PO1
CO3:	Select an appropriatesensor for various applications	PO1
CO4:	Outline about the data analytics and visualization of sensor data in various applications	PO1
CO5:	Experiment with appropriate sensing devices to measure the physical parameters from various environments.	PO1, PO2, PO4, PO5, PO9, PO10

MEASUREMENTS AND ERRORS **05**

Significance of measurement - Methods of measurements - Mechanical, Electrical and Electronic Instruments - Elements of generalized measurements system - Errors in Measurements- Calibration- Statistical analysis of errors - Units and standards.

SENSING TECHNIQUES **08**

Classification of sensors - Physical principle of sensing: Resistance, Capacitance, Inductance, Magnetism, Piezoelectric effect, Pyroelectric effect, Thermoelectric effect, Thermal properties of materials.

SENSOR APPLICATIONS **10**

Sensors For Industrial Automation - Sensors for Electric Vehicles - Sensors for Structural Health Monitoring - Measurement of room temperature using Thermistor - Sound measurement using sound and vibration sensors - Measurement of force using strain gauge and load cell.

SENSOR DATA ANALYTIC ARCHITECTURE 07

Sensor - Communication gateway - Data logging - Data warehouse - Data analytics.

Waste water treatment in industries and Drift control in BMW cars: Data set creation, Feature extraction, Model selection and Data visualization using simulation tool.

LIST OF EXPERIMENTS **15**

1. Design a signal conditioning circuit for the measurement of room temperature using thermistor.
2. Real time sound measurement in motor using sound and vibration sensor.
3. Measurement of angular displacement of stepper motor using Arduino.
4. Measurement of force using strain gauge and load cell.
5. Monitoring of battery usage using electronic battery sensor with Raspberry Pi.

Total Hours: 45 (30+15)

TEXT BOOKS

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", 4th Edition, Springer science and business media, 2010.
2. A.K.Sawhney "A Course in Electrical and Electronic Measurements and Instrumentation", 19th Edition, DhanpatRai& Co. (P) Ltd, 2019.

REFERENCES

1. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI Learning Private Limited, 2013.
2. Hermann K.P. Neubert, "Instrument Transducer", 2nd Edition, Oxford University press, 2015.
3. John Soldatos, "Building Blocks for IoT Analytics", River publishers, 2017.

WEB REFERENCES

1. www.scnsoft.com/blog/sensor-data-analytics.
2. https://www.bosch-mobility-solutions.com/en/products-and-services/passenger -cars-and-light-commercial-vehicles/interior-and-body-systems/body-electronics/electronic-battery-sensor/.
3. https://freevideolectures.com/course/3410/machinery-fault-diagnosis-and-signal-processing/16

20EI271 SIMULATION LABORATORY 0 0 2 1

Course Outcomes

On successful completion of the course, students will be able to

CO1	Outline the features of mathematical functions using computational software.	PO1,PO2,PO5,PO9
CO2	Develop a code utilizing basic commands and functions of simulation software to solve mathematical problems.	PO1,PO2,PO4, PO5,PO9
CO3	Analyze the variables within/import into workspace of software through plots and display devices.	PO1,PO2,PO4, PO5,PO9
CO4	Analyze the results and analysis of the experiments through reports.	PO1,PO2,PO4, PO5,P12

LIST OF EXPERIMENTS

1. Components of computational software and tool boxes
2. Mathematical operations using arrays and matrices.
3. Create and manipulate the variables for text and numeric data types.
4. Import and Export data as text files, spreadsheets, other file formats and web access.
5. Write basic programs using loops and conditional statements, such as if, for, and while.
6. Create variables within /import into Workspace of software from data files or other programs.
7. Solving Mathematical Functions using simulation tool.
8. Write basic Programs in Scripts containing sequence of commands and functions.
9. Create 2D,3D plots and display it in graphical window
10. Program to Read, Display and plot Image using open CV Library
11. Conversion of original image to Gray scale image and binary image.
12. Solving Matrices and Vectors problems using SCILAB.

20EI272 AEROSPACE SENSORS AND INSTRUMENTATION LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Demonstrate the working of sensors used for the measurement of physical parameters	PO1,PO2,PO4
CO2	Design a signal conditioning unit for the measurement of temperature	PO1,PO2,PO4
CO3	Construct an embedded system to monitor the physical parameters using simulation tool	PO1,PO2,PO4,PO5
CO4	Communicate the results of the experiments through reports.	PO5,PO9,PO10,PO12

LIST OF EXPERIMENTS

1. Determine the characteristics of proximity sensor using DC motor.
2. Measurement of angular displacement of using digital encoder.
3. Measurement of force using strain gauge
4. Level measurement using Ultrasonic sensor
5. Measurement of position using Hall Effect transducer.
6. Design a signal conditioning circuit for the measurement of room temperature using thermistor.
7. Monitoring of battery usage using electronic battery sensor with Raspberry Pi.
8. Monitoring of humidity using Ardinuo.
9. Monitoring of temperature using ESP 8266
10. Measurement of vibration and sound using simulation software

20EI218 CONTROL SYSTEMS IN AERONAUTICS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Develop various representations of system.	PO1, PO2
CO2	Infer the time domain and frequency domain specifications from the response.	PO1, PO2
CO3	Interpret the stability of systems in time and frequency domain.	PO1, PO2, PO3
CO4	Summarize the concepts of PID composite controllers.	PO1, PO2
CO5	Analyze higher order systems using appropriate software tools.	PO1, PO2, PO5

MODELING OF LINEAR TIME INVARIANT SYSTEM **8**

Control systems: Open loop and Closed loop - Feedback control system characteristics - First principle Modeling: Mechanical, Electrical and Hydraulic systems - Transfer function representations: Block diagram Reduction Techniques and Signal flow graph.

TIME DOMAIN AND STABILITY ANALYSIS **6**

Standard Test Inputs Signals - Time Responses - Time Domain Specifications-Steady State Error Analysis -Static and Dynamic Errors-Concept of Stability - Routh Hurwitz Stability Criterion - Root Locus.

FREQUENCY DOMAIN ANALYSIS **6**

Frequency Domain Techniques - Polar Plot - Bode Plot

CONTROLLERS **4**

On-Off Controller - Proportional, Proportional-Integral, Proportional-Derivative and Proportional-Integral-Derivative Composite Controllers.

STATE SPACE MODEL **6**

State Space Formulation - Physical, Phase, Canonical Variable Forms - State Transition Matrix using Laplace and Cayley Hamilton Theorem.

CASE STUDY

1. Vehicle Control Systems.
2. Design and analyze the DC Motor by State Space Modelling using soft tools.
3. Comparison of performance of PID Composite Controllers of Process Station using soft tools.

Total Hours: 30

TEXT BOOKS

1. Benjamin C. Ku and Farid Golnaraghi, "Automatic Control Systems", 10th Edition, McGraw-Hill Publishers, 2017
2. Nagarath I. J. and Gopal, M., "Control Systems Engineering", 6th Edition, New Age International Publishers, 2017.

REFERENCES

1. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Education Pearson, 13th Impression 2017.
2. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor and Francis, Reprint 2014.
3. Katsuhiko Ogata, "Modern Control Engineering", PHI Learning Private Ltd, Pearson, 5th Edition, 2015.

WEB REFERENCES

1. https://nptel.ac.in/courses/107/106/107106081/
2. https://nptel.ac.in/courses/108/106/108106098/
3. https://nptel.ac.in/courses/108/103/108103007/
4. https://nptel.ac.in/courses/112/107/112107240/
5 https://www.mathworks.com/help/control/ref/lti.pidtune.html;jsessionid=07b4962f334b78f14e6050642812

20IT201 PROBLEM SOLVING AND COMPUTER PROGRAMMING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the basics of computing and C programming.	-
CO2:	Demonstrate the understanding of programming evolution and C fundamentals.	-
CO3:	Apply C programming constructs to develop a solution for given scenario.	PO1
CO4:	Analyze the various programming constructs to solve the given problem.	PO2, PO9

INTRODUCTION TO COMPUTING & PROBLEM SOLVING **13**

Fundamentals of Computing - Moore's Law in Computer Industry - Evolution of Programming Languages - Algorithm, Pseudo-code and Flowchart - Introduction to problem solving aspects -Fundamental Algorithms - Factoring methods.

BASICS OF C & MODULAR APPROACH **20**

Structure of C program - Types, Operators and Expressions Evaluation - I/O Operations - Control Flow : Branching and Looping - Arrays - Strings - Pointers-Functions - Types of functions - User defined functions - Storage Classes and scope of variables -Different forms of functions - Parameter Passing - Call by Value - Call by reference - Passing array and strings as argument - Recursive function - Dynamic memory allocation.

USER DEFINED DATA TYPES & FILES **12**

Structure: Declaration, Initialization, passing structure to function - Use of pointers in structure - Self-referential structures - Union - Pre-processors, Macros - File management in C - I/O - Opening, closing and editing files.

Total Hours: 45

TEXT BOOKS

1. R. G. Dromey, "How to Solve it by Computer", Pearson Education, India, 2008.
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Prentice Hall of India, 1988.

REFERENCES

1. Byron Gottfried, "Schaum's Outline of Programming with C", 4th Edition, McGraw-Hill.
2. E. Balaguruswamy, "Programming in ANSI C", 8th Edition, Tata McGraw-Hill, 2019.
3. YashwantKanetkar, "Let us C", 16th Edition, BPB publishers, 2018.

WEB REFERENCES

1. https://nptel.ac.in/courses/106105171/
2. https://nptel.ac.in/courses/106104128/

20IT202 OBJECT ORIENTED PROGRAMMING CONCEPTS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the OOPS concepts and data visualization in Python.	-
CO2:	Interpret the various control structures, functions, OOPs concepts and data visualization concept.	-
CO3:	Develop Python programs using Object Oriented Programming concepts and exceptions.	PO1
CO4:	Analyze the suitable data structure for the given problem.	PO2, PO9

INTRODUCTION TO PYTHON **12**

Python Features - Python Data Types and Modules: Structuring code - Common data types - Python numbers - Strings - Lists - Dictionaries - Tuples - Sets - Files - Using data type methods - Importing modules - Logic Control - if…else statements - Loops - break, continue, pass and Loop else Comprehensions - Simple Programs using Python Data Types and Statements.

FUNCTIONS **6**

Python Built-In Function Basics - Python Scope Basics - Scopes and Nested Functions - Argument - Passing Basics - Lambdas.

OBJECT ORIENTED CONCEPTS IN PYTHON **12**

Introduction - Objects and Classes - Creating Python Classes - Basic Inheritance - Multiple Inheritance - Polymorphism - Abstract Base Classes.

OVERLOADING AND EXCEPTIONS **10**

Operator Overloading - The Basics - Object Destruction - Exception Basics - Catching Exceptions - Raising Exceptions - User Defined Exceptions - Exception Coding Details - Exception Objects: Class Based Exception - Nesting Exception Handlers.

CASE STUDY **5**

Introduction to Pygame - Simple Game Project - Data Visualization - Generating Data - Introduction to matplotlib - Plotting a simple line graph - Downloading Data - The CSV File Headers.

Total Hours: 45

TEXT BOOKS

1. "Learn Programming in Python with Cody Jackson", 1st Edition, Packet Publishing, 2018.
2. Dusty Phillips, "Python 3 - Object Oriented Programming", 3rd Edition, Packet Publishing Ltd. 2018.
3. Mark Lutz, "Learning Python", 5th Edition, O'Reilly Publishing, 2013.
4. Eric Matthes, "Python Crash Course", First Printing, no starch press, 2016.

REFERENCES

1. Guido van Rossum, "An Introduction to Python", Network Theory Ltd., 2011 - eBook (2018).
2. Allen B.Downey, "Think Python: How to Think Like a Computer Scientist", 3rd Edition, O'Reilly Publishers, 2018.
3. M.Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/106/106/106106145/
2. https://nptel.ac.in/courses/106/106/106106182/
3. python-course.eu/course.php

20IT241 PROGRAMMING IN PYTHON 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the fundamental concepts in Python.	PO1
CO2:	Demonstrate the various control statements, functions and exceptions.	PO1, PO2, PO9
CO3:	Apply the Python programming concepts for the given situation.	PO1, PO2, PO9
CO4:	Analyze the suitable data structure for the real time data.	PO1, PO2, PO9

INTRODUCTION TO PYTHON 10

Python Features - Python Interpreter - Program Execution - The Interactive Prompt - Python Data Types and Operations: Python Object Types, Numeric Types - String - Lists and Dictionaries - Tuples - Files- Arrays.

STATEMENTS AND SYNTAX 6

Python Statements -Assignments, Expressions and prints - if Tests and Syntax Rules - while and for Loops - Iterations and Comprehensions.

FUNCTIONS AND EXCEPTIONS 14

Function Basics- Scopes and Nested Functions -Argument - Passing Basics- Special Argument Matching modes - Anonymous functions: lambda -Module Creation - Module Usage - Package import Basics-Exception Basics-Exception Coding Details -Nesting Exception.

Total Hours: 30

TEXT BOOKS

1. Mark Lutz, "Learning Python", 5th Edition, O'Reilly Publishing, 2013.
2. Allen B.Downey, "Think Python: How to Think Like a Computer Scientist", 3rd Edition, updated for Python 3, O'Reilly Publishers, 2018.

REFERENCES

1. Joshua Welsh, "Python for Beginners: The Ultimate Guide to Python Programming; Learn Python FAST!", Create Space Independent Publishing Platform, 2016.
2. Leonardo Gorman, "Python for Beginners: A Simple and Concise Guide to Learn Coding Fast", Create Space Independent Publishing Platform, 1st Edition, 2016.
3. Martin Laredo, "Python Programming For Beginners: Crash Course", Create Space Independent Publishing Platform, 2016.

WEB REFERENCES

1. https://nptel.ac.in/courses/106/106/106106145/
2. https://nptel.ac.in/courses/106/106/106106182/
3. python-course.eu/course.php

20IT242 OBJECT ORIENTED PROGRAMMING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the basics of object-oriented programming paradigms.	-
CO2:	Demonstrate the implementation of control structures and object-oriented programming concepts.	-
CO3:	Apply the knowledge of object-oriented programming concepts to solve a given problem.	PO1
CO4:	Analyze the given problem to determine the solution using appropriate OOPs concepts.	PO2,PO9

INTRODUCTION TO OBJECT - ORIENTED PROGRAMMING **14**

Procedural programming and Object-Oriented Programming - C++ Programming Basics: Basic Program Construction Data Types, Variables, Constants, Type Conversion, Operators, Library Functions, Loops and Decisions, Structures, Functions - Simple Functions, Passing, arguments, Returning values, Reference Arguments, Recursion, Inline Functions, Default, Arguments Storage Classes, Arrays - Strings.

FEATURES OF OBJECT - ORIENTED PROGRAMMING **13**

Introduction to Classes and Objects - Constructors and its types, Destructors - Passing Objects as Function arguments and Returning Objects from Functions - Operator Overloading - Inheritance - Overloading Member Functions - Pointers - Virtual Functions - Friend Functions, Static Functions.

STREAMS AND FILES **7**

Streams: Classes and Errors - Disk File I/O with Streams - Files: File Pointers, Error handling in File I/O, File I/O with member Functions - Overloading the extraction and Insertion Operators - Multi File Programs.

TEMPLATES, EXCEPTIONS AND STANDARD TEMPLATE LIBRARY **11**

Templates - Function templates, Class templates, Exceptions: Need of Exceptions, keywords, Simple and Multiple exceptions, Re-throwing Exception and Exception Specifications, Custom Exception. Introduction to STL: Containers, Algorithms, iterators - potential problems with STL Algorithms: find(), count(), sort(), search(), merge().

Total Hours: 45

TEXT BOOKS

1. Robert Lafore, "Object-Oriented Programming in C++", 4th Edition, SAMS Publishing, 2008.
2. Deitel, "C++ How to Program", 6th Edition, PHI publication, 2008.

REFERENCES

1. Joyce Farrell, "Object Oriented Programming", 4th Edition, Cengage learning, 2009.
2. Nicolai M. Jossutis, "Object-Oriented Programming in C++", Wiley Publications, 2002.
3. BjarneStroustrup , "The C++ Programming Language", 4th Edition, Addison Wesley, 2015.
4. Stanley Lippman, JoseeLajoie, Barbara E. Moo, "C++ Primer", 5th Edition, Addison Wesley, 2015.

WEB REFERENCE

1. https://nptel.ac.in/courses/106/105/106105151/

20IT243 DATA STRUCTURES AND ALGORITHMS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define and list the application areas of linear and nonlinear data structures.	-
CO2:	Illustrate the operations on different types of data structures.	-
CO3:	Apply the concept of linear and nonlinear data structures to for a given application.	PO1
CO4:	Analyze the implementations of suitable data structures for a given scenario based on complexity analysis	PO2, PO9

INTRODUCTION **6**

Data objects and Structures, Algorithm Specification-Introduction, Recursive algorithms, Data Abstraction, Performance analysis- time complexity and space complexity, Asymptotic Notation-Big O, Omega and Theta notations, Complexity Analysis Examples, Introduction to Linear and Non Linear data structures.

LINEAR DATA STRUCTURES **12**

Representation of single, two dimensional arrays, sparse matrices-array and inked representations. Linear list ADT-array representation and linked representation, Singly Linked Lists- Operations-Insertion, Deletion, Circularly linked lists-Operations for Circularly linked lists, Doubly Linked Lists- Operations- Insertion, Deletion.

Stack ADT, definition, array and linked implementations, applications-infix to postfix conversion, Postfix expression evaluation, recursion implementation, Queue ADT, definition, array and linked Implementations, Circular queues-Insertion and deletion operations.

NON-LINEAR DATA STRUCTURES **18**

Trees - definition, terminology, Binary trees-definition, Properties of Binary Trees, Binary Tree ADT, representation of Binary Trees-array and linked representations, Binary Tree traversals, Threaded binary trees, Search Trees-Binary Search Tree ADT, Definition, Operations- Searching, Insertion and Deletion, AVL Tree. Priority Queues -Definition and applications, Max Priority Queue ADT-implementation-Max Heap-Definition, Insertion into a Max Heap, Deletion from a Max Heap.

Graphs-Definitions, Terminology, Applications and more definitions, Properties, Graph ADT, Graph Representations- Adjacency matrix, Adjacency lists, Graph Search methods - DFS and BFS, Complexity analysis - Shortest path algorithm - Minimum spanning Tree.

SORTING AND SEARCHING **9**

Searching - Linear Search, Binary Search, Hashing-Introduction, hash tables, hash functions, Overflow Handling, Comparison of Searching methods. Sorting-Insertion Sort, Selection Sort, Radix Sort, Quick sort, Heap Sort, Merge sort, Comparison of Sorting methods.

Total Hours:45

TEXT BOOKS

1. Sartaj Sahni , Data structures, Algorithms and Applications in C++, 2nd Edition, Universities Press.2010
2. Adam Drozdek, Data structures and Algorithms in C++, 4th edition, Cengage learning, 2012

REFERENCES

1. J. Hubbard, Data structures with C++, Schaum's outlines, TMH,2017
2. M.T. Goodrich, R. Tamassia and D. Mount, Data structures and Algorithms in C++, Wiley India,2011
3. M. A. Weiss, Data structures and Algorithm Analysis in C++, 3rd edition, Pearson.2008

WEB REFERENCES

1. https://nptel.ac.in/courses/106/102/106102064/
2. https://nptel.ac.in/courses/106/106/106106127/

20IT244 PYTHON PROGRAMMING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the fundamental and OOPS concepts in Python.	-
CO2:	Illustrate the various control structures, functions, exceptions and OOPs concepts.	-
CO3:	Develop Python programs using Object Oriented Programming concepts.	PO1
CO4:	Analyze the suitable data structure for the real time data.	PO2,PO9

INTRODUCTION TO PYTHON PROGRAMMING **12**

Introduction to Python Language: IDLE, Data types, naming conventions, built-in-functions-Data Collection and language components: Control structures, indenting, Operators, Lists, Tuple, Sets, Dictionaries, Copying Collections.

FUNCTIONS AND MODULES **12**

Functions: Defining and Calling a Function, Passing Arguments to functions - Mutable and Immutable data type, Different types of arguments, Lambda, Modules- Standard Modules,dir() function.

PACKAGES AND EXCEPTIONS **9**

Packages, Exceptions- Model, Hierarchy, handling multiple exceptions, regular expressions.

OBJECT ORIENTED CONCEPTS IN PYTHON **12**

Basic Object Oriented Concepts, Creating classes and Variables, Method Invocation, Using default arguments in methods, Static class and Instance methods, Polymorphism and Inheritance.

Total Hours: 45

TEXT BOOKS

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python - Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES

1. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
2. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press, 2013
3. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning,2012.

WEB REFERENCE

1. https://nptel.ac.in/courses/106/106/106106182/

20IT251 MULTIMEDIA PRINCIPLES AND WEB DESIGN 1 0 2 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the basic concepts of design factors in terms of human perception, visual and animation.	-
CO2:	Demonstrate the understanding of learning domains, user interface design, visual design elements and 2D design.	-
CO3:	Develop user interface & visual design for a given problem statement.	PO1
CO4:	Apply multimedia tools and web technologies for developing web pages.	PO1, PO2, PO3, PO5, PO9, PO10
CO5:	Analyze the appropriate use of multimedia tools and web technologies for developing web pages.	PO1, PO2, PO3, PO5, PO9, PO10
CO6:	Design web pages using web technologies such as HTML5 & CSS3.	PO1, PO2, PO3, PO5, PO9, PO10

DESIGN OVERVIEW **6**

Need for design - Human factors -Fundamentals of Human perception - Human skill level and behavior -Dialogues and tasks - Learning and Learning Modes - Cognitive Domain Learning - Affective and Psychomotor Domain Learning - Multimedia Educational Software Modeling, System Quality - Elements of user interface - Guidelines for user interface design.

VISUAL DESIGN AND ANIMATION DESIGN **9**

Introduction to basic visual elements - Line shape, colour, texture, layout, motion, framing, surfaces, visual hierarchy, typography - Visual design methodology: Clarity, consistency, appearance, visual coding layout principles - Drawing for Animation - 2D Design concepts & Composition - Editing & Animatics - Sound Effects - Sound Recording - Visual Effects.

Total Hours: 15

List of Excerises

MULTIMEDIA

ADOBE PHOTOSHOP

1. Working with Images
2. Painting, Drawing and Retouching Tools
3. Working with Layers and Filters

ADOBE FLASH

4. Working with Graphics and Colors
5. Creating animation effects
6. Applying Filters and Layers

WEB DESIGN

HTML 5

7. Basic HTML and Formatting Tags
8. Hypertext Links and List
9. Images, Tables, Frames and Forms

CSS 3

10. Embedding CSS into HTML
11. Selectors, Backgrounds and Colors
12. Text, Fonts, Links, Lists, Tables and Images

Total Hours: 30

TEXT BOOKS

1. David Benyon, "Designing Interactive Systems: People, Activities, Contexts, Technologies", 3rd Edition 2013, Pearson Education.
2. Lisa DaNaeDayley, Brad Dayley, "Photoshop CC Bible", 1st Edition, 2013, Wiley India.
3. Thomas A. Powell, "HTML & CSS: The Complete Reference", 5th Edition, 2010, McGrawHill.
4. Robert Reinhardt and Snow Dowd, "Macromedia Flash 8 Bible", 1st Edition, 2006, WileyIndia.

REFERENCES

1. David A. Lauer and Stephen Pentak, "Design Basics", 8th Edition 2016, Wadsworth Publishing Company.
2. Kevin Mullet and Darrell Sano, "Designing Visual Interfaces: Communication Oriented Techniques", 1st Edition, 2008, Prentice Hall.
3. Terry Michael Savage and Karla E Vogel, "An Introduction to Digital Multimedia", 2nd Edition, 2014, Burlington, Mass: John & Bartlett Learning.
4. Andy Chong, "Basics Animation: Digital Animation", 1st Edition 2007, AVA Publishing.
5. Vikas Gupta, "Multimedia and Web Design", Reprint Edition 2009, Dreamtech press.

WEB REFERENCES

1. https://www.w3schools.com/html/
2. https://www.w3schools.com/css/
3. https://www.tutorialspoint.com/

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define Data science process and descriptive statistics using R.	-
CO2:	Demonstrate the use data structures and R Packages for different applications	-
CO3:	Make use of various programming constructs and data pre-processing techniques using R to solve problems.	PO1,PO5
CO4:	Analyze the data from different sources and visualize the results using R	PO2,PO5

DATA SCIENCE FUNDAMENTALS **10**

Introduction to Data Science- KDD Process- Introduction to data pre-processing, R Basics: The R Programming Language- Installation- Comparison with other programming languages and Features- Basic Experiments- Variable - Data operators- R Data types: Vectors, Lists, Matrices, Array, Factors, Data Frames

R PROGRAMMING **10**

R statements- R Loops- R Functions: Built in and User defined-Vector and Matrix manipulation functions, R - strings and string manipulation functions- R Data Interfaces: CSV Files, Excel Files, Database-Working with structured and unstructured data-Scoping rules in R-Package in R: Installing and Loading Packages in R, using help, access functions from packages.

EXPLORATORY DATA ANALYSIS **10**

Data Visualization:Histograms charts, Dot Plots, Line Charts, Pie Charts, Boxplots, Scatterplots, saving and exporting results- Data Pre-processing: Data cleansing, Treating missing values, data transformations, sampling data for modelling- test and training splits, creating sample groups, Data reduction. R - Descriptive Statistics: arithmetic mean, median, Measure of dispersion - Minimum and Maximum values, quantiles, percentiles, IQR, standard deviation, variance.

List of Excerises

1. Basic Experiments with R
2. R Data Operators
3. R Data types
4. Import and Export of data in R
5. Data Visualization
6. Data Pre-Processing- Basic steps
7. R functions
8. R Packages
9. Case study: Loading and processing of Financial (or) Medical (or) Weather (or) Stock Market data (or) Sports data, visually inspecting and analysing using statistical estimates

Total Hours30 (T) + 15(L): 45

TEXT BOOKS

1. Andrew Oleksy,Data Science with R: A Step By Step Guide with Visual Illustrations & Examples, 2018
2. Nina Zumel and John Mount, Practical Data Science with R, Dreamtech/Manning, 2014

REFERENCES

1. R for Data Science, Hadley Wickham and Garett Grolemund, , O'Reilly, 2017
2. Data Mining for Business Analytics: Concepts, Techniques and Applications in R, GalitShmueli, et al, Wiley India, 2018.
3. Roger D. Peng, R Programming for Data Science, Lean publishing, 2015

WEB REFERENCES

1. https://nptel.ac.in/courses/111/104/111104100/
2. https://onlinecourses.nptel.ac.in/noc19_ma33/preview

20IT270 C PROGRAMMING LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Experiment with the commands in Linux OS.	PO1
CO2:	Apply branching and looping construct to solve problems.	PO1, PO2, PO3
CO3:	Make use of functions, Arrays and Pointer concepts in programming.	PO1, PO2, PO3
CO4:	Develop programs using user defined data types and files.	PO1, PO2, PO3

List of Excerises

1. Familiarization of basic LINUX commands and execution of sample programs
2. Expression evaluation using operators
3. Conditional control structures
4. Loops
5. Different approaches to find smallest divisor of an integer
6. Permutation and Combinations in problem solving
7. User defined functions
8. Recursive functions
9. Arrays
10. Pointers and Dynamic memory allocation
11. Structures and Union
12. Files

WEB REFERENCE

1. http://cse02-iiith.vlabs.ac.in/ (Computer programming lab)

ENLIGHTENMENT THROUGH EDUCATION SREC

20IT271 OBJECT ORIENTED PROGRAMMING LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Build Python programs using fundamental programming concepts.	PO1, PO2, PO3
CO2:	Apply Object-oriented programming concepts to implement Python scripts.	PO1, PO2, PO3
CO3:	Construct Python programs using files and exception handlers.	PO1, PO2, PO3
CO4:	Develop simple game and line graph.	PO1, PO2, PO3

List of Excerises

1. Integrated Development Environment - Shell mode & Script mode
2. Operators and Expressions
3. Lists, Tuples, Sets, Dictionaries and Strings
4. Decision Statements - if, elif
5. Loop Control Statements - for, while
6. Functions and Modules
7. Object-Oriented Programming: Class, Objects
8. Inheritance
9. Polymorphism
10. Errors and Exceptions
11. Files
12. Simple Game and Line graph

WEB REFERENCES

1. https://nptel.ac.in/courses/106/106/106106145/
2. https://nptel.ac.in/courses/106/106/106106182/
3. python-course.eu/course.php

ENLIGHTENMENT THROUGH EDUCATION ★ CREC ★

20IT291 PROGRAMMING IN PYTHON LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Build Python programs using fundamental programming concepts.	PO1, PO2, PO3
CO2:	Construct Python programs using files, exception handlers and Packages.	PO1, PO2, PO3

List of Excerises

1. Shell Scripting, GUI Environment
2. Operators and Expressions
3. Lists, Dictionaries, Tuples, Range, Strings, Set
4. Arrays
5. Selection Statements - if, elif
6. Iteration Statements - while, for
7. Built-In Functions
8. Function and Modules
9. Files
10. Exceptions
11. Packages

WEB REFERENCES

1. https://nptel.ac.in/courses/106/106/106106145/
2. https://nptel.ac.in/courses/106/106/106106182/
3. python-course.eu/course.php

ENLIGHTENMENT THROUGH EDUCATION SREC

20IT292 OBJECT ORIENTED PROGRAMMING USING C++ LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Develop programs using object-oriented programming concepts.	PO1,PO2,PO3
CO2:	Construct programs using files.	PO1,PO2,PO3

List of Excerises

1. Class and objects - Creating class, objects, access specifiers, object as array, arguments, returning objects.
2. Constructors and destructors - Default Constructors, Parameterized constructors, Copy constructors.
3. Friend function and Friend class.
4. Polymorphism - function overloading, overloading unary and binary operators.
5. Pointers - operations on pointers, passing pointers to function, passing an entire array to afunction.
6. Inheritance - Single, multiple, hierarchical, multi-level, hybrid.
7. Function overriding, virtual base class, Creation of pure virtual function using new and deleteoperator.
8. File Manipulation.
9. Templates - class templates, function templates.
10. Exception handling.

WEB REFERENCE

1. https://nptel.ac.in/courses/106/105/106105151/

20IT293 DATA STRUCTURES AND ALGORITHMS LABORATORY 0 0 2 1

COURSE OUTCOMES:

On successful completion of the course, the students will be able to:

CO1:	Analyze, Design and Implement operations on linear data structures	PO1,PO2,PO3
CO2:	Analyze and Implement various searching techniques	PO1,PO2,PO3
CO3:	Analyze and Implement various sorting techniques	PO1,PO2,PO3
CO4:	Analyze, Design and implement operations on trees and graph traversal	PO1,PO2,PO3

List of Excerises

1. Implementing an ADT using a C++ class
2. Array Implementation of the List ADT
3. Array and singly linked list implementations of a stack
4. Array and singly linked list implementations of a queue
5. Singly Linked List Implementation of the List ADT
6. Doubly Linked List Implementation of the List ADT
7. Sorting Algorithms
8. Search Algorithms
9. Linked implementation of a binary search tree
10. Graph Traversal - DFS & BFS

WEB REFERENCES

1. https://nptel.ac.in/courses/106/103/106103069/
2. https://ds1-iiith.vlabs.ac.in/data-structures-1/
3. https://ds2-iiith.vlabs.ac.in/data-structures-2/

20IT294 PYTHON PROGRAMMING LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Construct programs using Python core data structures	PO1, PO2,PO3
CO2:	Apply the concepts of modules and packages to solve problems	PO1, PO2,PO3
CO3:	Develop Python scripts using fundamental OOPs concepts	PO1, PO2,PO3

List of Excerises

1. Operators and expressions
2. Lists, Dictionaries, Tuples, Range, Strings, Set
3. Control Structures
4. Functions and Modules
5. Packages
6. Exceptions
7. Regular Expressions
8. Objects, Classes, Constructors and Destructors.
9. Polymorphism.
10. GUI Toolkits(Tkinter, PyQT)

WEB REFERENCE

1. https://nptel.ac.in/courses/106/106/106106182/

ENLIGHTENMENT THROUGH EDUCATION SREC

20IT252 JAVA PROGRAMMING 2 0 2 3

PREREQUISITE

20IT202 - Object Oriented Programming Concepts

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the basic concepts of Java language.	PO1, PO2, PO3, PO12
CO2:	Design and develop a Java application using Swing, establish database connectivity with JDBC, streams and networking.	PO2, PO3, PO5, PO12
CO3:	Develop Java applications using collection framework and functional programming.	PO2, PO3, PO5, PO12
CO4:	Develop a simple Java application, use functional programming and test the application using JUnit.	PO1, PO2, PO3, PO5, PO12
CO5:	Develop Java applications using Swing, collection framework, JDBC and client/server concepts.	PO2, PO3, PO5, PO9, PO12
CO6:	Communicate the programming results through reports.	PO9, PO10, PO12

INTRODUCTION TO JAVA CONCEPTS **10**

Java Evolution -Data Types -Variables -Control Statements -Methods and Classes -Arrays -String Handling -Inheritance -Exception Handling -Multithreaded Programming -Interfaces -Packages.

SWING, JDBC, I/O STREAMS AND NETWORKING **12**

Swing Components: J Button -J Text Field -J Table -J Scroll Pane -J List -Java Database Connectivity with JDBC -Input Output: Stream Classes -Byte Stream -Character Stream -Serialization -Files-Networking: URL -URL Connection - Http URL Connection -TCP/IPClientSockets -TCP/IPServer Sockets.

COLLECTION FRAME WORK AND FUNCTIONAL PROGRAMMING **8**

Introduction: Annotations -Auto boxing -Java Collection Framework: Vector -List -Tree Set -Hash Map -Enum -Stack -Queue -Deque -New Features: Lamda expressions -Functional Interfaces -Method References.

List of Excerises (Using Eclipse IDE 2020-12): **15**

1. Arrays and String using Control Structures
2. Exception handling
3. Inheritance and Interfaces
4. Packages
5. Multithreading
6. Test applications using JUnit
7. Functional Programming: Lamda Expressions and Functional Interfaces

CASE STUDY

8. Java application using Collection Framework and JDBC
9. GUI application using Swing with Client/Server concepts

Total Hours: 45

TEXT BOOKS

1. Ian F. Darwin, "Java Cookbook", 4th Edition, O'Reilly Media, Inc, 2020.
2. E. Balagurusamy, "Programming with Java", 6th Edition, Tata McGraw Hill Publications, 2019.

REFERENCES

1. Y.Daniel Liang, "Introduction to Java Programming: Brief Version", 10th Edition, Pearson, 2014.
2. Elliote Harold Rusty, "Java Network Programming", 4th Edition, O'Reilly Media, 2013.

WEB REFERENCES

1. https://nptel.ac.in/courses/106/105/106105191/
2. https://www.tutorialspoint.com/java/

20IT272 PROGRAMMING IN C++ LABORATORY 0 0 2 1

PREREQUISITES

20IT270 - C Programming Laboratory

20IT271 - Object Oriented Programming Laboratory

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Construct C++ programs using Encapsulation, Polymorphism and Inheritance.	PO1, PO2, PO3, PO12
CO2:	Develop C++ programs using pointers and files concept.	PO1, PO2, PO3, PO12
CO3:	Apply templates and exception handling concepts to write C++ programs.	PO1, PO2, PO3, PO12
CO4:	Communicate the programming results through reports.	PO9, PO10, PO12

List of Excerises

1. Class and Objects, Object as array, arguments, returning objects.
2. Types of Constructors and Destructors
3. Friend function and Friend class.
4. Function overloading
5. Unary and Binary operator overloading.
6. Pointer operations, passing pointers to function, passing an entire array to a function.
7. Single, multiple, hierarchical, multi-level, hybrid Inheritance.
8. Virtual base class, Pure virtual function.
9. File Manipulation.
10. Types of Templates.
11. Exception handling.

WEB REFERENCE

1. https://nptel.ac.in/courses/106/105/106105151/

20IT295 PROGRAMMING SKILLS LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Construct Python Scripts using collections.	PO1, PO2, PO3, PO12
CO2:	Make use of control statements and functions to develop Python scripts.	PO1, PO2, PO3, PO12
CO3:	Apply the concept of files, exception handling and packages.	PO1, PO2, PO3, PO12
CO4:	Communicate the programming results through reports.	PO9, PO10, PO12

List of Excerises

1. Shell Scripting, GUI Environment
2. Operators and Expressions
3. Lists, Dictionaries, Tuples, Range, Strings, Set
4. Arrays
5. Selection Statements -if, elif
6. Iteration Statements -while, for
7. Built-In Functions
8. Function and Modules
9. Files
10. Exceptions
11. Packages

WEB REFERENCES

1. https://nptel.ac.in/courses/106/106/106106145/
2. https://nptel.ac.in/courses/106/106/106106182/
3. python-course.eu/course.php

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME201 ENGINEERING THERMODYNAMICS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Solve the thermodynamic properties of a system undergoing energy interactions by applying energy balance.	PO1, PO2
CO2:	Apply Laws of Thermodynamics to various thermal systems for estimating their performance	PO1, PO2
CO3:	Outline the thermodynamic properties of the pure substances	PO1
CO4:	Estimate the properties of the steam and efficiency of vapour power cycles.	PO1, PO2

BASIC CONCEPTS AND FIRST LAW **15**

Microscopic and Macroscopic approaches - Concept of Continuum - Thermodynamic Systems - Property - State and Process - Point and Path Functions - Thermodynamic Equilibrium - Quasi Static Process - Work and Heat Concept of Temperature - Zeroth Law of Thermodynamics.

First Law of Thermodynamics: Statement - Internal Energy - Specific Heat Capacities -Enthalpy- Application to Non - Flow Systems - Steady Flow Energy Equations - Application to various flow systems.

SECOND LAW AND AVAILABILITY ANALYSIS **15**

Second Law of Thermodynamics: Statements and their equivalence - Cyclic Heat Engine - Refrigerator and Heat Pump - Reversible and Irreversible Processes - Carnot Cycle and Carnot Theorem - Clausius Inequality - Clausius Theorem - Entropy - Principle of increase of entropy - Entropy generation - Available Energy and Irreversibility - Second law efficiency.

PROPERTIES OF PURE SUBSTANCES **15**

Thermodynamic properties of pure substances in solid, liquid and vapor phases - Phase Rule: P-V, P-T, T-V, T-S, H-S diagrams - P-V-T surfaces - Thermodynamic properties of steam - Steam formation - Use of Steam Tables Mollier Diagram - Determination of Dryness fraction - Rankine cycle - Modified Rankine Cycle - Methods to improve efficiency of Rankine cycle - Reheat and Regenerative cycles - Binary Vapour Cycle.

Total Hours: 45

TEXT BOOKS

1. Yunus.A.Cengel, and Michael A.Boles, "Thermodynamics", Tata McGraw Hill, 8th Edition, 2014.
2. Nag.P.K, "Engineering Thermodynamics", Tata McGraw-Hill, 5th Edition, 2013.

REFERENCES

1. VanWylen G.J, Sontag R.E. "Classical Thermodynamics", Wiley Eastern, 3rd Edition, 1987.
2. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 12th Reprint, 2007.
3. Rajput R.K, "A Text Book of Engineering Thermodynamics", Laxmi Publications, 5th Edition, 2017.

DATA BOOK

1. Kothandaraman C.P., Steam Tables, New Age International, 4th Edition, 2015.

WEB REFERENCES

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://ocw.mit.edu/high-school/physics/exam-prep/kinetic-theory-thermodynamics/laws-of-thermodynamics/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME202 MANUFACTURING TECHNOLOGY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the elements of fundamental manufacturing processes	PO1, PO2
CO2:	Summarize the metal forming processes along with their applications	PO1, PO2
CO3:	Relate the mechanisms of metal cutting and chip formation.	PO1, PO2
CO4:	Describe the metal machining and finishing processes	PO1, PO2
CO5:	Illustrate the features of Industry 4.0 and Smart Manufacturing	PO1, PO2, PO5

PREREQUISITE: Basic Workshop Practices Laboratory

FOUNDRY PROCESSES **10**

Patterns: Types, Selection and Allowances. Moulding Sands: Types and Properties, Core: Classification and Requirements- Core Prints, Sand Moulding Process and Gating systems Melting Furnaces: Crucible, Cupola and Induction; Casting processes: Sand Casting, Investment Casting and Die Casting: Fettling and Cleaning of Castings, Casting Defects and Remedies

METAL FORMING AND JOINING PROCESSES **12**

Cold and hot working: Rolling, Drawing, Extrusion and Forging processes: Operations, Applications and Defects; Sheet metal processing: Blanking, Piercing, Swaging, Coining, Embossing, Bending, Drawing - operations and their applications

Welding: Classification, Welding Electrodes, Welding types: Oxy-Acetylene, TIG, MIG and Spot; Weld defects and remedies.

METAL CUTTING AND MACHINING PROCESSES **18**

Tool Materials and their properties, Single point cutting tool nomenclature, Chip formation: Types of Chips, Orthogonal and Oblique Cutting, Cutting Fluids, Tool Life, Taylor's tool life equation and types of tool wear. Working Principle, Operations and Applications of Lathe, Drilling and Milling machines

Surface finishing processes: Grinding, Lapping and Broaching machines.

SMART MANUFACTURING **5**

Introduction – Elements of Industry 4.0 - IIoT– Conversion of existing system into smart manufacturing system

Total Hours: 45

TEXT BOOKS

1. Khanna O. P, "Production Technology- Vol-1", DhanpatRai Publications, Revised Edition New Delhi, 2015
2. Rao.P.N., "Manufacturing Technology-Vol-1"cGraw Hill Education, 4th Edition, New Delhi, 2017.
3. Rao.P.N., "Manufacturing Technology-Vol-2", McGraw Hill Education, 3rd Edition, New Delhi, 2017

REFERENCES

1. Richard Heine, Carl Loper, Philip Rosenthal, "Principles of Metal Casting", McGraw Hill Education, 2nd Edition (Indian Edition), 2017
2. ChattopadhyayA.B, "Machining and Machine Tools", Wiley Publications, 2nd Edition, New Delhi, 2017
3. Shan H. S, "Manufacturing Processes: Casting, Forming and Welding", Cambridge University Press, 2nd Edition Mumbai 2017.

20ME204 COMPUTATIONAL MECHANICS 3 1 0 4

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Solve the system of forces acting on the rigid bodies and support reactions on beams.	PO1, PO2, PO5
CO2:	Interpret the principles of kinematics of rigid bodies	PO1, PO2, PO5
CO3:	Solve the stress and strain acting on the bodies due to axial forces.	PO1, PO2, PO5
CO4:	Construct the Shear force and Bending Moment diagrams for cantilever beams by resolving their transverse loads	PO1, PO2, PO5
CO5:	Make use of Pascal's law to measure the pressure using manometers.	PO1, PO2, PO5
CO6:	Apply continuity equation for fluid kinematic applications	PO1, PO2, PO5

MECHANICS OF RIGID BODIES **22**

Forces and their types - Resolution of forces - Equilibrium of rigid bodies, Free body diagram - Equations of Equilibrium, Moment and couple - Structural Analysis of beams - Friction - Kinematics of rigid bodies -Uniform acceleration - Motion under gravity - Angular motion - Relative motion.

MECHANICS OF DEFORMABLE BODIES **22**

Stress and strain due to axial force - Elastic limit - Hooke's law - Factor of safety - Stepped bars - Stresses in composite bars due to axial force - Lateral strain - Poisson's ratio - Volumetric strain - Stress-Strain Diagram - Relationship between load, shear force and bending moment - Shear force and bending moment diagrams for cantilever beams.

MECHANICS OF FLUID BODIES **16**

Fluid statics: Fluid properties - Pascal's law - Relationship between Pressures - Pressure measurements by manometers.

Fluid Kinematics: Significance of Kinematics and Kinetics - Types of flow - Velocity field and acceleration - Continuity equation and its applications.

Note: Practice using suitable computational tools in solving the problems is desirable.

Total Hours: 60

TEXTBOOK

1. Beer F.P. and Johnston E.R., Vector Mechanics for Engineers - Volume I - Statics, Volume II - Dynamics, McGraw Hill, New York, 2004.
2. Bansal.R.K, "A text book of Strength of Materials", Laxmi Publications Pvt. Ltd., 6th Edition, New Delhi, 2012.
3. Modi P.N, Seth S.M "Hydraulics and Fluid Mechanics Including Hydraulic Machines" (In SI Units), 19th Edition. Standard book house Publications (P) Ltd, 2011.
4. Elementary Mechanics Using Matlab - Malthe& Sorensen - Undergraduate Lecture Notes in Physics, Springer International Publishing, 2015.

REFERENCES

1. Hibbeler R. C., Engineering Mechanics: Statics and Dynamics, 11th Edition, Pearson Education India, 2017.
2. Punmia B.C, Ashok Jain and Arun Jain., "Strength of Materials and Theory of Structures - Vol-I", Laxmi Publications, 2nd Edition, New Delhi, 2000.
3. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 9th Edition, Laxmi publications (P) Ltd, 2015.
4. Statics with Matlab - Marghitu, Dupac& Madsen, Springer - Verlag London 2013.

WEB REFERENCE

1. https://swayam.gov.in/nd1_noc20_me01

20ME205 THERMAL ENGINEERING AND FLUID MECHANICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the construction and working of Internal Combustion Engine	PO1
CO2:	Compare various Air Standard Cycles	PO1,PO2
CO3:	Apply the principles of heat transfer in engineering applications	PO1,PO2
CO4:	Summarize the properties of fluid and their flow measurement.	PO1,PO2
CO5:	Describe the construction and working of Hydraulic Machines	PO1

IC ENGINES AND AIR STANDARD CYCLES **10**

Classification of I.C. engines - Working of four stroke and two stroke cycle engines - Working principle of spark ignition and compression ignition engines- Actual PV diagrams- Air standard cycles - Otto cycle, diesel cycle, dual cycle, Brayton cycle - Determination of efficiency and mean effective pressure.

HEAT TRANSFER **10**

Modes of Heat Transfer -Conduction- Fourier Law of Conduction - Thermal Conductivity - Conduction Through Slab, composite wall, cylinder -Convection - Heat Transfer Coefficient, Natural and Forced Convection, Combined Conduction and Convection, concept of thermal resistance. Critical thickness of insulation. Fins and their application- Cooling of electronic components: Thermoelectric cooling - Chip cooling.

FLUID MECHANICS **12**

Fluid properties - Thermal material properties-Newton's Law of viscosity, Pressure, Measurement of Pressure, Pascal's law. Continuity equation, Euler's equation, Bernoulli's equation. Flow measuring instruments-Venturimeter, orifice meter, Pitot tubes. Loss of energy in flow through pipes - Major and Minor losses - Darcy Weisbach equation - Chezy's formula.

HYDRAULIC MACHINES **13**

Turbines: Pelton Wheel- major parts, construction, working -Francis turbine - major parts, construction, working, Kaplan turbine - major parts, construction, working - Heads and efficiencies, specific speed, unit quantities, Characteristic Curves .

Pumps: Centrifugal Pump - major parts, construction, working, Heads and Efficiencies ,Specific Speed, Characteristic Curves, Cavitation, Maximum Suction Lift, Net Positive Suction Head (NPSH) - Reciprocating pumps - major parts, construction, working, discharge, work done, power required and slip in a reciprocating pump-Constant and variable speed pump

Total Hours: 45

TEXT BOOKS

1. Rajput R.K., "Thermal Engineering", 10th Edition, Lakshmi Publications, 2018.
2. Bansal R.K, "Fluid Mechanics and Hydraulic Machines", 10th Edition, Laxmi Publication Pvt. Ltd, 2019.
3. Ballaney P.L., "Thermal Engineering", 25th Edition, CRC Publications, 2015.

REFERENCES

1. Nag P. K, "Engineering Thermodynamics", 6th Edition, McGraw Hill Publications, 2017.
2. Yunus A Cengel and Michael A Boles, "Thermodynamics an Engineering Approach", 9th Edition, McGraw Hill Publications, 2019.
3. Sarkar B.K, "Thermal Engineering", 5th Edition, McGraw Hill Publications, 2017

Web References

1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/106/112106200/

20ME208 INTRODUCTION TO ROBOTICS 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the configuration and architecture of robotics.	PO1, PO2
CO2:	Summarize the subsystems of industrial robots	PO1, PO2
CO3:	Explain the applications of industrial robots	PO1, PO2
CO4:	Describe the legged and wheeled mobile robots used for locomotion.	PO1, PO2

OVERVIEW OF ROBOTICS **6**

Evolution - Classification - Laws of Robotics - Structure and Configuration, Characteristics, Components of Robots and General Architecture - Development Trends in Robotics.

INDUSTRIAL ROBOTS AND THEIR APPLICATIONS **12**

Robot subsystems - Robot Vision - Artificial Intelligence - Industrial Automation - Underwater Robots - Flying Robots - Robots in Painting, Gluing, Handling, Tending, Hemming, riveting, laser cutting and Welding.

AUTONOMOUS MOBILE ROBOTS **12**

Locomotion - key issues for locomotion, legged mobile robots, leg configurations and stability, examples of legged robot locomotion, wheeled mobile robots, wheeled locomotion-the design space, wheeled locomotion: case studies.

Total Periods: 30

TEXT BOOKS:

1. Robotics, Appin knowledge solutions, Infinity Science Press LLC, Hingham, Massachusetts, New Delhi 2007.
2. R.K.Saha - Introduction to Robotics - McGraw Hill Education (India) Private Limited, New Delhi, 2014.
3. Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots, Second Edition", MIT Press, 2004.

REFERENCE BOOKS:

1. H.F. Davidson, Lester Gerhardt, Michael Brady, Robotics and Artificial Intelligence, Springer Berlin Heidelberg, 2012
2. Mordechai Ben-Ari, Francesco Mondada, Elements of Robotics, Springer International Publishing, 2017.

20ME271 ENGINEERING GRAPHICS 0 0 4 2

COURSE OUTCOMES

On successful completion of the course, Students will be able to

CO1:	Construct the plane geometric entities using BIS conventions.	PO1, PO2, PO9, PO10, PO12
CO2:	Illustrate the orthographic projections of solids and their sectional views.	PO1, PO2, PO9, PO10, PO12
CO3:	Develop the lateral surfaces of the simple solids.	PO1, PO2, PO9, PO10, PO12
CO4:	Project the isometric views of solids and convert their isometric projections into orthographic projections and vice versa.	PO1, PO2, PO9, PO10, PO12
CO5:	Model two dimensional geometric entities using a computerized drafting package.	PO1, PO2, PO5, PO9, PO10, PO12

INTRODUCTION **2**

Drawing Instruments - Drawing Sheet size and Layout - BIS conventions and specifications - Lettering - Geometrical Constructions and Dimensioning - Scales: Reducing Scale and Enlarging Scale.

PLANE GEOMETRY **5**

Curves used in Engineering Practices: Construction of Conics by eccentricity method - Cycloidal Curves - Involutes of Polygons and Circle - Construction of tangent and normal at a point on the curves.

SOLID GEOMETRY **28**

Orthographic Projection: Principles of Orthographic projection - First angle projection - Conventional representation

Projection of Points and Straight Lines: Projection of points, Projection of straight lines inclined to both the reference planes by rotating line method - Determination of True length and True inclinations.

Projection of Solids: Projection of simple solids like Prisms, Pyramids, Cylinder and Cone with the axis inclined to one reference plane and parallel to other plane.

Section of Solids and Development of Lateral Surfaces: Section of Solids in Simple Position when the cutting plane is inclined to one of the reference planes and perpendicular to the other - Obtaining True Shape of section, Development of lateral surfaces of simple and truncated solids - Prisms, pyramids, cylinders and cones.

PICTORIAL PROJECTIONS **10**

Isometric Projections: Principles, views of Simple Solids and Truncated Solids - Prisms, Pyramids, Cylinders and Cones.

Free hand sketching: Visualization concepts - Layout of views - Conversion from Pictorial Projection to Orthographic Projection and vice versa for Simple objects.

COMPUTER AIDED DRAFTING **15**

Introduction to software - Layout of software, standard toolbars/Menus, coordinate systems and reference planes - selection of drawing size and scale - Title block. Use of commands like points, line, curve, polygon, mirror, move and dimensions to draw lines, solids and section of solids.

Note: Exercises should be practiced by using drawing instruments and drafting software.

Total Hours: 60

TEXT BOOKS

1. Venugopal K. and Prabhu Raja V., "Engineering Graphics", 14th Edition, New Age International (P) Limited, 2018.
2. Murthy S T, "Computer Aided Engineering Drawing", I.K. International Publishing House Pvt. Limited, 2011.

REFERENCES

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition,2014.
2. Kumar M.S., "Engineering Graphics", DD Publications, 2012.
3. Dhananjay A Jolhe, "Engineering Drawing with an Introduction to AutoCAD", McGraw Hill Education, 2017.

PUBLICATION OF BUREAU OF INDIAN STANDARDS

1. IS 10711 - 2001: Technical products Documentation - Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) - 2001: Technical products Documentation - Lettering.
3. IS 10714 (Part 20) - 2001 & SP 46 - 2003: Lines for technical drawings.
4. IS 11669 - 1986 & SP 46 - 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) - 2001: Technical drawings - Projection Methods.

WEB REFERENCE

1. https://nptel.ac.in/courses/112103019/

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

20ME272 COMPUTER AIDED ENGINEERING GRAPHICS LABORATORY 0 0 4 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Create geometric models using the basic commands and features of the drafting software.	PO1, PO5, PO9, PO10
CO2:	Construct simple geometric entities and their projections as per the BIS conventions.	PO1, PO5, PO9, PO10
CO3:	Convert the pictorial projections of geometric entities into orthographic projections.	PO1, PO5, PO9, PO10
CO4:	Draw the isometric view of simple geometric models.	PO1, PO5, PO9, PO10
CO5:	Manipulate the geometric entities created using drafting software.	PO1, PO5, PO9, PO10

INTRODUCTION

Graphics in engineering applications - Use of Drawing Instruments - BIS conventions and specifications- Lettering -Geometrical Constructions and Dimensioning Scales. Introduction to drafting software - Standard tool bars/Menus, coordinate systems and reference planes - selection of drawing size and scale - Title block.

LIST OF EXPERIMENTS

1. Creation of drawing sheet layouts and title block.
2. Model simple two-dimensional graphical entities using absolute and relative co-ordinate methods.
3. Projection of points.
4. Projection of straight lines.
5. Projection of simple solids.
6. Construction of orthographic views of simple solids.
7. Modeling of isometric view of simple solids.

REFERENCES

1. Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", 14thEdition, New Age International (P) Limited, 2018.
2. Murthy, S. T., "Computer Aided Engineering Drawing", I.K. International Publishing House Pvt. Limited, 2011.

Publication of Bureau of Indian Standards:

1. IS 10711 - 2001: Technical products Documentation - Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) - 2001: Technical products Documentation - Lettering.
3. IS 10714 (Part 20) - 2001 & SP 46 - 2003: Lines for technical drawings.
4. IS 11669 - 1986 & SP 46 - 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) - 2001: Technical drawings - Projection Methods.

WEB REFERENCE

1. https://nptel.ac.in/courses/112103019/

20ME273 ENGINEERING PRACTICES LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Explain the plumbing layout for residential and industrial buildings.	PO1, PO2, PO9, PO10, PO12
CO2:	Model the required fitment in wood and metallic blanks using appropriate tools.	PO1, PO2, PO9, PO10, PO12
CO3:	Develop the basic automation unit to perform the required function	PO1, PO2, PO9, PO10, PO12
CO4:	Outline the wiring layout for residence, considering the safety	PO1, PO2, PO9, PO10, PO12
CO5:	Show the working of basic electronic instruments and logic gates	PO1, PO2, PO5, PO9, PO10, PO12
CO6	Organize OS and its drivers in a computer system.	PO1, PO2, PO5, PO9, PO10, PO12

LIST OF EXPERIMENTS

CIVIL ENGINEERING

1. Safety aspects of plumbing in residential and industrial buildings
2. Preparation of plumbing - line sketches for water and sewage work in residence
3. Cutting and threading of pipes
4. Pipe connections using different fittings
5. Making pipe connections for motor
6. Demonstration of plumbing requirement for high raise buildings

MECHANICAL ENGINEERING

1. Making a fitting joint: V joint/ Square joint
2. Making a carpentry joint: T joint/ Dove Tail joint
3. Weld Joints of lap joint/ T joint
4. Assembling a timing belt driven linear carriage
5. Assembling a lead screw driven linear carriage
6. Making an assembly of spur gear drive
7. Making an assembly of bevel gear drive
8. Making an assembly of Worm gear drive
9. Assembling a mechanically driven belt conveyor

10. Assembling a timing belt driven cam and follower setup

ELECTRICAL ENGINEERING

1. Measurement of electrical quantities voltage, current, power & power factor in RLC circuit.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Residential house wiring using switches, fuse, lamp and energy meter.
5. Measurement of earth resistance, winding resistance and insulation resistance.
6. Study of Indian Electricity rules and safety.

ELECTRONICS ENGINEERING

1. Study of operating procedures of CRO, DSOs, Multimeters etc.,
2. Resistor colour coding, and measurement of parameters of square wave and sine wave signals (peak-peak, RMS, period and frequency).
3. Study of logic gates.
4. Soldering practices using general purpose PCB.

COMPUTER SOFTWARE & HARDWARE

1. Demonstration of Personal Computer Components
2. Disassembly and Assembly of Personal Computer
3. Analysis of BIOS or UEFI Settings and Installation of Operating systems (Linux and Windows)
4. Installation of Device Drivers for the external peripherals devices
5. Identification of Networking devices and tools

NOTE: The chairperson of the respective Board of Studies may choose minimum of 12 exercises from the given list of exercises.

ENRICHMENT THROUGH EDUCATION SREC

20ME211 **STRENGTH OF MATERIALS** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Interpret relationship between stress, strain and elastic constants	PO1, PO2, PO3
CO2	Illustrate shear force diagram, bending moment diagram and deflection of beams for the given load conditions	PO1, PO2, PO3
CO3	Identify the different biaxial stresses in the plane and circular cross section for the given application.	PO1, PO2, PO3
CO4	Determine the torsional stresses in shafts and helical springs.	PO1, PO2, PO3
CO5	Predict the buckling strength of the column.	PO1, PO2, PO3

AXIAL LOADING **7**

Stress and strain due to axial force -Stepped bars -Uniform and varying sections -Stresses in composite bars due to axial force and temperature. Elastic Constants.

TRANSVERSE LOADING **14**

Relationship between load, shear force and bending moment -Shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads-Theory of simple bending -Analysis of Bending stress. Deflection of beams -Macaulay's method.

BI-AXIAL STRESSES **10**

Introduction, Plane stress, stresses on inclined sections, Principal stresses and Maximum shear stresses by analytical method. Hoop and longitudinal stresses in thin cylindrical and spherical shells under internal pressure -Change in length dimension and volume.

TORSION AND SPRINGS **8**

Theory of torsion and assumptions -Equation of pure Torsion -Strength of the shaft and Torsional Rigidity-Power transmitted by a shaft -Stresses in solid and hollow circular shafts. Shear stress distribution -Shear flow in Rectangular, circular and I-Sections. Helical springs - Closed and Open coil.

COLUMNS **6**

Theory of columns -Long column and short column - Euler's formula and Rankine's formula.

Total Periods: 45

TEXT BOOKS

1. Rattan, "Strength of Materials",3rd Edition, McGraw Hill Education India, 2014.
2. Bansal R.K., "Strength of Materials", 6th Edition, Laxmi Publications, 2018.

REFERENCES

1. Punmia B.C, Ashok Jain and Arun Jain., "Strength of Materials and Theory of Structures-Vol-I", 3rd Edition, Laxmi Publications, 2017.
2. Kazmi S.M.A., "Solid Mechanics", 2nd Edition, Tata McGraw Hill Edu. Pvt. Ltd.,2017.

WEB REFERENCE

1. https://nptel.ac.in/courses/105/105/105105108/

20ME213 RESOURCE MANAGEMENT AND OPTIMIZATION TECHNIQUES 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Formulate and solve a Linear Programming Model using Graphical method.	PO1, PO2, PO4, PO11
CO2	Optimize the solutions to Transportation models through different approaches.	PO1, PO2, PO4, PO11
CO3	Apply PERT / CPM techniques to optimize the duration of a project	PO1, PO2, PO4, PO11
CO4	Make decisions through application of game theory, replacement models and queuing strategy.	PO1, PO2, PO4, PO11
CO5	Outline the concepts and applications of Nonlinear optimization Techniques.	PO1, PO2, PO4, PO5,PO11

INTRODUCTION AND LINEAR PROGRAMMING **6**

Introduction: Historical overview of operations research, fundamentals of OR, Linear Programming, formulation of L.P model- graphical solution.

Transportation problems: Optimal solution by North West corner method- Least cost method -Vogel's approximation method -Optimality test -MODI method-degeneracy-Unbalanced transportation problems

PROJECT MANAGEMENT **6**

Network models - Basic Concepts - Construction of Networks - Project Network - CPM and PERT -Critical Path Scheduling -Crashing of Network.

DECISION MODELS AND QUEUING MODELS **12**

Game theory-Two-person zero sum game -Graphic solution -Property of dominance - Algebraic solution. Replacement models-Items that deteriorate with time -When money value changes -Items that fail completely - Individual replacement and Group replacement.

Queuing-Poisson arrivals and Exponential service times -Single channel models [(M/M/1): (GD/∞/∞, (M/M/1): (GD/N/∞) Model)] and Multi-channel models [(M/M/C): (GD/∞/∞), (M/M/C): (GD/N/∞)]

MODERN METHODS OF OPTIMIZATION **6**

Introduction: Fuzzy logic, Genetic algorithm (GA), Simulated annealing algorithm (SA), Ant colony optimization algorithm (ACO), Neural networks, Applications.

Total Periods: 30

TEXT BOOKS

1. Taha H.A., "Operation Research: An Introduction", Prentice Hall, 9th Edition, 2010.
2. Panneerselvan. R., "Operation Research", Prentice Hall of India Pvt Ltd, 2th Edition,2006.
3. Hira and Gupta., "Introduction to Operations Research", S.Chand Ltd, 3rd Edition, 2008.
4. Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers - 2012 - 4th Edition.

REFERENCE BOOKS

1. Dharani Venkatkrishna., "Operations Research", Keerthi Publishing House, 2011.
2. Kanti Swarup, Gupta P.K., and Manmohan, (2010), Operations Research, S. Chand & Sons
3. Panneerselvam, R., "Design and Analysis of Algorithms- 2nd Edition", Prentice Hall of India Pvt Ltd, 2nd Edition, 2016.

20EE240 FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Solve the electric circuits by relating the basic laws of Electrical Engineering.	PO1, PO2, PO5
CO2	Describe the construction and operation of DC machines, transformers and induction motors	PO1, PO2, PO5
CO3	Compare the different types of motors pertaining to their industrial applications.	PO1, PO2, PO5
CO4	Outline the characteristics of semiconductor devices, electronic circuits and their applications.	PO1, PO2, PO5
CO5	Demonstrate the real-time applications using AVR RISC Microcontroller and ARDUINO.	PO1, PO2, PO5, PO9, PO10

ELECTRIC CIRCUITS **8**

Ohm's law, Kirchhoff's law - Series and Parallel connections - Solving simple DC Circuits - Single phase AC circuit fundamentals - Power, Power factor - Solving simple AC Circuits - Three phase AC circuits - Star and Delta Connections

DC MOTORS **5**

Principle of operation - Types - Significance of Back EMF - Speed, Torque - Speed-Torque characteristics - Losses and Efficiency - Speed control of DC motor - Electric Braking - Applications

TRANSFORMERS AND AC MOTORS **6**

Single Phase Transformer - Construction and Principle of operation - Types - Auto Transformer - Applications

Three phase Induction Motor - Construction -Principle of operation - Types - Torque equation - Speed-Torque characteristics - Single phase Induction Motor - Principle of operation and Applications

Introduction to Alternators

INDUSTRIAL APPLICATIONS **4**

Motor Selection - Factors to be considered - Power rating - Types of Duty Cycle - Selection of motors for machine tool applications and centrifugal pumps

ELECTRONICS **10**

PN Junction Diodes, BJT construction and working principle - Circuits: Rectifier, Power supply, Voltage Regulator - Basics of Amplifiers and Oscillators - Integrated Circuits: Operational amplifiers - Characteristics and applications. Digital Circuits - A/D and D/A

AVR RISC MICROCONTROLLER AND APPLICATIONS **12**

Overview of AVR RISC architecture - Getting started with ARDUINO IDE - C Language basics- Programs using ARDUINO - Interfacing ARDUINO with Pressure, Temperature and Speed sensors - Bluetooth and Ethernet

Total Periods: 45

TEXTBOOKS

1. Muthusubramanian .R, Salaivahanan .S, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, 2nd Edition, 2011.
2. Thomas .L Floyd, "Electronic Devices Conventional Current Version", Pearson, 10th Edition, 2018.
3. Thomas Grace,"Programming and Interfacing ATMEL's AVRs", 1st Edition, Cengage Learning, 2016.

REFERENCES

1. Nagrath .I .J, Kothari .D .P, "Electrical Machines", Tata McGraw Hill, 5th Edition, 2017.
2. Pillai.S.K, "A First Course on Electrical Drives", New Age International Publications Limited, 2011.
3. Robert .L Boylestad, Louis Nashalskey, "Electronic Devices and Circuits", PearsonEducation, India, 11th Edition, 2015.
4. M. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson, 6th Edition, 2017.
5. Simon Monk, "Programming Arduino, Getting Started with Sketches", McGraw Hill Education, 2012.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/108/108108076/
2. https://nptel.ac.in/courses/108/105/108105053/
3. https://nptel.ac.in/courses/108/105/108105017/
4. https://nptel.ac.in/courses/122/106/122106025/

ENLIGHTENMENT THROUGH EDUCATION SREC

20EE281 FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Infer the different laws of Electrical Engineering and interpret the results	PO1, PO2, PO4,PO5
CO2	Analyse the various speed control techniques and load test in DC shunt motors and Induction motor	PO1, PO2, PO4,PO5
CO3	Evaluate the performance characteristics of semiconductor diode	PO1, PO2, PO4,PO5
CO4	Design and implement the real-time applications of Electric and Electronic circuits.	PO1, PO2, PO4,PO5
CO5	Communicate the results of the experiments through reports	PO1, PO2, PO4,PO5

LIST OF EXPERIMENTS

1. Verification of Ohm's Law and Kirchhoff's law
2. Measurement of resistance, inductance and capacitance
3. Load test on DC motor
4. Speed Control of DC motor
5. Load Test on Three phase Induction Motor
6. Speed Control of Three phase slip ring IM
7. VI characteristics of PN junction diode
8. Simulation of Electric circuits
9. Design of Regulated Power Supply
10. Real-time applications using ARDUINO

Total Periods: 30

OPEN ELECTIVES (OEs)

ENLIGHTENMENT THROUGH EDUCATION
SREC

20AE2E51 MODELING OF MINI AND MICRO AIR VEHICLES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe Unmanned Aerial Vehicles and the standards followed	PO2, PO7
CO2:	Describe the components of Unmanned Aerial Vehicle	PO2, PO3
CO3:	Tell about the components and operations of propulsion system used in UAV	PO2, PO3
CO4:	Describe Flight controllers and its functions	PO2, PO3

INTRODUCTION **15**

Unmanned Aerial Vehicle - Introduction and developments, applications - UAS Classification - Fixed wing, Flapping Wing, Rotary wing, Multi rotors, LTA Systems - Design Standards - USA and Europe - Fixed Wing - components and Working Principle - Propulsion systems - Electric and Engine powered, control system, Telemetry - Multi rotors - Components - Effect of Environment in UAV systems - Case Study: DJI Spark

PROPULSION SYSTEMS **12**

Electric - Brushed and Brushless Motors, Electronic Speed Control Unit, Power Source - Propellers - Nomenclature and Types - Engine - types of engine, fuel types - Engine control systems - Hybrid Propulsion System

FLIGHT CONTROL SYSTEM **18**

Sensors - accelerometer, gyros, magnetometer, barometric sensor, Ultrasonic transducers - Commercial Flight Controllers - Arduino, Raspberry Pi, TI CC3200 MCU boards, Break Out Boards - Case Study: Ardupilot Flight Controller

Total Periods: 45

TEXT BOOKS

1. Kimmon P Valavanis, George J Vachtsevanos, 'Handbook of Unmanned Aerial Vehicles' Springer, 2015

REFERENCES

1. Ridhwan U Razeen, 'Design of Midrange Unmanned Aerial Vehicle', Lap Lambert Academic Publishing, 2015.

2. Paul Gerin Fahlstrom, Thomas James Gleason, 'Introduction To UAV Systems', John Wiley & Sons Ltd, 2012.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc16_me04/preview

20AE2E52 **FUNDAMENTALS OF APPLIED AERONAUTICAL SCIENCES** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the components of airplane and the historical milestones in aviation	PO2, PO3
CO2:	Explain the elementary concepts that govern the aircraft flight	PO2, PO3
CO3:	Summarize communication systems and their development	PO2, PO3
CO4:	Understand the controls of airplane using simulator	PO2, PO3

AVIATION DEVELOPMENT **11**

History of Aviation - Components of an Airplane and their functions - Conventional and Powered Controls - Basic Instruments for flying - Frontiers of Aerospace Engineering

SCIENCE OF FLIGHT **11**

Aerodynamics: Science behind bird Flight - Ornithopters - Aerodynamic characteristics of Airfoils - Mach Number - Speed Regimes - Basic ideas about Air breathing Engines

COMMUNICATION SYSTEMS **12**

Aircraft communication systems - Global positioning system principles - Auto Pilot System

FLIGHT SIMULATOR BASICS **11**

Learning your Airplane - Pre-flight procedures - Basic aircraft controls - Instrument panel - Taxiing - Take-off - Cruising- Landing - Stalling and recovery - Navigation controls - Visual Flight Rules - Instrument Flight Rules - Flying at night - Flying in changing weather conditions - Cross-Country flight

Total Periods: 45

TEXT BOOKS

1. Anderson, J.D., "Introduction to flight", 8th Edition, McGraw Hill, 2015.

REFERENCES

1. Dala R. Cundy, Rich S. Brown, "Introduction to Avionics", 2nd Edition, Pearson, 2011.

2. Ralph D. Bent & James L. Mackinley, "Aircraft Basic Science", 6th Edition, McGraw-Hill, 1988.

20AE2E53 VEHICLE AERODYNAMICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the basics of aerodynamics	PO1, PO2
CO2:	Illustrate the flow phenomena around vehicles	PO1, PO2
CO3:	Define drags of vehicles	PO1, PO2
CO4:	Define stability factors of a vehicle	PO1, PO2
CO5:	Describe about wind tunnels	PO1, PO2
CO6:	Describe wind tunnel visualization techniques	PO1, PO2

FUNDAMENTALS OF AERODYNAMICS **12**

Fundamentals of fluid mechanics - flow phenomenon related to vehicles - external and internal flow problem - resistance to vehicle motion - fuel consumption and performance potential of vehicle aerodynamics - Concept of bluff body, Generic shapes, relevance of shapes to ground vehicles

AERODYNAMIC DRAG **11**

Car as a bluff body - drag force - types of drag force - Pressure drag and viscous drag - analysis of aerodynamic drag - drag coefficient of cars - strategies for aerodynamic development - low drag profiles

STABILITY FACTORS **13**

The origin of forces and moments - vehicle dynamics under side wind - Force and Moment coefficients - Important factors affecting Aerodynamics : rear slant - engine cooling air drag - cross winds - underside flow - wheel rotation - Airflow around individual components

WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS **9**

Principle of wind tunnel technology - stress with scale models - full scale wind tunnels - Visualization techniques - measurement techniques

Total Periods: 45

TEXT BOOK

1. Hucho.W.H., "Aerodynamic of Road Vehicles", Butterworths Co., Ltd., 1998.
2. A.Pope, "Wind Tunnel Testing", John Wiley & Sons, 2nd Edition ,New York, 1974.

REFERENCES

1. E.L.Houghton & P.L Carpenter, "Aerodynamics for Engineering Students", Butterworth Heinman, 2003.
2. "Automotive Aerodynamics", Society of Automotive Engineers Inc., 1978.
3. "Vehicle Aerodynamics", Society of Automotive Engineers Inc., 1996
4. Heinz Heisler, "Advanced Vehicle Technology", second edition, Butterworth -Heinemann, New York, 2002

20AE2E54 AUTOMOTIVE AERODYNAMICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the application fluid mechanics on automotives	PO1
CO2:	Generalize the drag force on cars	PO1
CO3:	Explain the shape optimizing techniques on cars	PO1
CO4:	Explain the characteristics of aerodynamics forces affecting vehicle handling	PO1
CO5:	Illustrate the wind tunnel technology and its types	PO1, PO5
CO6:	Summarize the equipments used for different wind tunnel testing methods	PO1, PO5

INTRODUCTION **7**

Fundamental of fluid mechanics - flow phenomenon related to vehicles - external and internal flow problem - engine cooling requirement - air flow to passenger compartment - duct for air conditioning - cooling of transverse engine and rear engine

AERODYNAMIC DRAG OF CARS **8**

Forces on car - Lift force - Cars as a bluff body - flow field around car - drag force - types of drag force - analysis of aerodynamic drag - drag coefficient of cars - strategies for aerodynamic development - low drag profiles.

SHAPEOPTIMIZATION OF CARS **8**

Front end modification - front and rear wind shield angle - boat tailing, hatch back - fast back and square Back - dust flow patterns at the rear - effects of gap configuration - effect of fasteners

MOTOR CYCLE AERODYNAMICS **4**

Effect of aerodynamics on motorcycle - Turbulence on motor cycle - Chassis development

VEHICLE HANDLING **8**

The origin of forces and moments on a vehicle - vehicle dynamics under side winds - the effects and characteristics of forces and moments - dirt accumulation on the vehicle - wind noise - drag reduction in commercial vehicles

WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS **10**

Principle of wind tunnel - types - limitation of simulation - scale models - full scale wind tunnels - measurement techniques - equipment and transducers - road testing methods - Numerical testing methods.

Total Periods: 45

TEXT BOOK

1. Hucho.W.H., "Aerodynamic of Road Vehicles", Butterworths Co., Ltd., 5th Edition, 2015.

REFERENCES

1. Jewel B. Barlow, William H. Rae, Alan Melvill Pope, Ahmad Kassaee, "Wind Tunnel Testing", John Wiley & Sons, 4th Edition, New York, 2015.

2. Vehicle Aerodynamics, SP-1145, SAE, 1996.

20AE2E55 SPACE: THE FINAL FRONTIER 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the solar system and its structure	PO1
CO2:	Explain the characteristics of stars	PO1
CO3:	Discuss the types of Galaxies	PO1
CO4:	Summarize the formation of the Universe	PO1
CO5:	Describe the current trends of Space Exploration	PO1
CO6:	Summarize the future aspects of Space Exploration	PO1

THE SOLAR SYSTEM **7**

Structure of the Solar System - Birth of the Solar System - The Sun - The Solar Cycle - Earth - The Moon - Planets - Asteroids - Pluto - The Kuiper Belt - Comets and the Oort Cloud

STARS **8**

Types of stars - Inside stars - Formation - Nebulae - Star Clusters - Constellations - Exoplanets - Red Giants - Planetary Nebulae - White Dwarfs - Supergiants - Pulsars - Black holes

GALAXIES AND THE UNIVERSE **15**

The Milky Way - Magnellanic Clouds - Andromeda - Spiral Galaxies - Elliptical Galaxies - Dwarf Galaxies - Active Galaxies - Collisions - Galaxy clusters and superclusters - Dark Matter - Mapping the Universe - Light - Space-time - Expanding Universe - Big Bang - Early radiation - Early particles - First stars and galaxies - Future of the Universe

SPACE EXPLORATION **15**

Getting into Space - Rockets - Reusable Rockets - Satellite Orbits - Types of Satellites - Hubble Space Telescope - Space Probes and Orbiters - Propulsion in Space - Crewed Spacecraft - Spacesuits - Space Shuttle - Space Stations - Future Spacecraft

Total Periods: 45

TEXT BOOK

1. "How Space Works: The Facts Visually Explained", United Kingdom, Dorling Kindersley Limited, 2021.

REFERENCES

1. Sparke, Linda S., and Gallagher, John S., "Galaxies in the Universe: An Introduction", Cambridge University Press, 2000.
2. Woolfson, Michael, "Formation Of The Solar System, The: Theories Old And New (2nd Edition)", World Scientific Publishing Company, 2014.
3. Encrenaz, Thérèse, et al. "The Solar System", Springer Berlin Heidelberg, 2013.

20AE2E56 ELECTRIC AVIATION 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the Electric Aircraft	PO1
CO2:	Explain the Aerodynamics in an Electric Aircraft	PO1
CO3:	Summarize the technologies used in Electric Propulsion	PO1
CO4:	Explain the concept of Electrification of Aircraft Systems	PO1
CO5:	Discuss on the Disruptions in the Aircraft Industry	PO1, PO7

INTRODUCTION **8**

Introduction to Electric Aircraft - History of Electric Aviation - Hybrid and all Electric Aircraft - Battery Power, Range and Endurance - Electric Propulsion - Current Technology and Limitations

AERODYNAMICS **9**

Airfoil and Airframe Design - Propeller Design - Aerodynamic Drag - Boundary Layers - Drag Reduction

ELECTRIC PROPULSION **9**

Hybrid-Electric Propulsion - Turbo-Electric Propulsion - All Electric Propulsion - Distributed Electric Propulsion (DEP) - Electric Motors: Permanent Magnet Motors - High Temperature Superconducting Motors - Batteries: Rechargeable batteries - Temperature effects and Capacity fading - Fuel Cells

ELECTRIFICATION OF AIRCRAT SYSTEMS **10**

Conventional Systems - Electrical Power Generation and Distribution - Power Electronics - Shift from Hydraulic to Electric Powered Actuation - Flight Control and Autonomous Operations

DISRUPTION IN THE AIRCRAFT INDUSTRY **9**

eAircraft Market evaluation - Start-Up Airlines - Sustainable Aviation Fuel - eVTOLs - UAM - Revolutionary Aircraft Redesign - Digitalisation of Aviation Industry

Total Periods : 45

TEXT BOOK

1. Vepa, Ranjan, "Electric Aircraft Dynamics - A Systems Engineering Approach", CRC Press, Taylor & Francis Group, 2020.
2. Thalin, Pascal, et. al, "Fundamentals of Electric Aircraft", SAE International, 2018.

REFERENCES

1. Schwab, Amy, et. al, "Electrification of Aircraft: Challenges, Barriers, and Potential Impacts", NREL, 2021.

20AD2E51 PYTHON FRAMEWORKS FOR MACHINE LEARNING 2 0 2 3

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1:	Outline the fundamental concepts of Python programming	PO1, PO2, PO5, PO12
CO2:	Develop applications using various machine learning algorithms to solve problems	PO2, PO3, PO4, PO5, PO12
CO3:	Build neural networks using Tensor Flow framework for solving complex problems	PO2, PO3, PO4, PO5, PO6, PO12
CO4:	Make use of Python libraries and frameworks in developing real time applications.	PO2, PO3, PO4, PO5, PO6, PO12

INTRODUCTION TO PYTHON CONCEPTS **7**

DataTypes,Variables,functions,String,Tuples,Lists,Dictionaries,Regularexpressions,Classes,handlingexceptions.

MACHINE LEARNING ALGORITHMS WITH SCIK IT-LEARN **10**

Pandas Library, Numpy library, Using Scikit-Learn for Logistic Regression, Decision Tree classifier, Random Forest classifier, Support Vector Machines, Building Neural Networks.

INTRODUCTION TO TENSOR FLOW **8**

Concept of Computational Graph and Nodes,Virtual Environment and Anaconda, Installing Tensor Flow with GPU support, TF Data types, Placeholders, TF Variables, TF Session, Soft max, One Hot Encoding, Dropout, building hidden layers, Batching, Stochastic Gradient Descent, Building an Optimizer, Training and displaying results.

APPLICATIONS **5**

Building a Machine Learning Application using Scikit-Building a Neural Network with Tensor Flow: Using inbuilt Tensor Flow functionality to build a Neural Network and train on MNIST Data set for classification.

LIST OF EXERCISES:

1. Vector and Matrix manipulation
2. Dataset representation using pandas

Using scikit learn

3. Linear regression
4. Binary classification using classifiers
5. Multiclass classification using classifiers
6. Analyze the classification report

Using TensorFlow

7. Creating tensor and computation graph
8. Construct single layer neural network
9. Build multi-layer neural network with optimizers
10. Training Neural Network on MNIST dataset

Total Hours(30 Theory + 15 Lab): 45

TEXTBOOKS:

1. Andreas C.Müller, Sarah Guido,"Introduction to Machine Learning with Python", O' Reilly Media, Inc., 2016
2. Aurélien Géron,"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow,2nd Edition, O'Reilly Media, Inc.,2019.

REFERENCEBOOKS:

1. Anurag Gupta, G Biswas, "Python Programming",1st Edition, Tata McGraw Hill, 2019
2. Sebastian Raschka, "Python Machine Learning", 3rd Edition, Packt Publishers, 2019.
3. Giancarlo Zaccone , "Getting Started with Tensor Flow", Packt Publishers,2016.
4. Richert & Coelho, "Building Machine Learning Systems with Python", Packt Publishers, 2013.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://nptel.ac.in/courses/106/106/106106213/

20BM2E31 HEALTHCARE TECHNOLOGY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify the need of understanding human anatomy and physiology system	PO1
CO2:	Select the suitable acquisition method for analysing biomedical signal and vital parameters measurement.	PO1, PO5
CO3:	Apply the knowledge of biomedical instruments to practical applications.	PO1, PO5
CO4:	Identify the various therapeutic devices for pulmonary diseases.	PO1, PO5
CO5:	Interpret the technique used for visualizing various sections of the body using imaging techniques.	PO1, PO5

NTRODUCTION TO PHYSIOLCIAL SYSTEMS & BIO SIGNALS **8**

The cell and its electrical activity-Principle physiological system: Cardiovascular System, Nervous system, Respiratory system, Muscular system -Origin of bioelectric signal -Bioelectric signals: ECG, EMG, EEG, EOG and their characteristics.

MEASUREMENT OF PHYSIOLOGICAL PARAMETERS **8**

Measurement of Blood pressure, Cardiac output measurement, Heart rate, Respiration rate, Measurement of lung volume and capacity and Oximeters.

THERAPEUTIC EQUIPMENTS **12**

Defibrillators, Pacemaker, Heart Lung machine, Dialyser, Anaesthesia machine and Ventilators.

PULMONARY ANALYZERS AND OPTICAL EQUIPMENTS **10**

Regulation of Breathing, Pulmonary gas flow measurements, Pulmonary volume measurements, Respiratory gas Analyzers, Nitrogen Gas Analyzer, Oxygen Analyzer.

IMAGING TECHNIQUE **7**

X-ray, Computational Tomography, MRI instrumentation and Ultrasound scanner.

Total Hours: 45

TEXT BOOKS

1. Joseph J.carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley &Sons, 1997.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rd Edition,Tata McGraw-Hill, 2014.
3. Carolyn D. Berdanier, Johanna T. Dwyer, David Heber. "Handbook of Nutrition and Food" 3rd Edition, CRC Press, 2013.

REFERENCES

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley &Sons, 1998.
2. Leslie Cromwell, Fred J.Weibell, Erich A. Pfeiffer, "Bio-Medical Instrumentation and Measurements", 2nd Edition, Pearson Education, 2005.

20BM2E32 MATERIALS IN MEDICINE 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Classify materials used for implant applications	PO1, PO5
CO2:	Indicate their structure property relationships and tissue response to the materials used.	PO1, PO5
CO3:	Describe the properties of metallic alloys and ceramic materials, polymer, composite materials as suitable for biomedical applications.	PO1, PO5
CO4:	Categorize the materials for soft and hard tissue replacements.	PO1, PO5
CO5:	Describe the concepts of tissue engineering.	PO1, PO5

STRUCTURE OF BIO MATERIALS AND BIO COMPATIBILITY **15**

Classification of biomaterials, structure property relationship in biomaterials - Mechanical properties and testing, viscoelasticity. Body response to implants, biocompatibility testing of materials, standards for testing. Metallic implant materials. Ceramic implant materials. Polymers. Composites. Nanostructured Biomaterials, Surface modification and surface characterization of Biomaterials. Issues and challenges in the use of metallic alloys, ceramics, polymers and composites.

TISSUE REPLACEMENT IMPLANTS **20**

Soft-Tissue replacements - sutures, skin implants - artificial skin and tissue engineered skin, maxillofacial augmentation, ear and eye implants, maxillofacial reconstruction. Blood interfacing implants - Blood substitutes and catheters; cardiovascular grafts and stents; heart valve implants- mechanical models, total artificial heart, left ventricular assist devices - design; Artificial kidney - hemodialysis, CAD tools in design and CFD tools in testing of designs. 3D printing and digital manufacturing of artificial organs.

Hard tissue replacement implants - artificial ligaments and tendons, bone cements, long bone repair- bone screws and pins, intramedullary wires, cortical and cancellous bone plates. Joint replacements - total hip replacement, knee replacements, meniscal repair. Dental restorations and implants.

TRANSPLANTS AND TISSUE ENGINEERING MATERIALS **10**

Transplants - immunological considerations, blood transfusions, organ transplants. Tissue engineering -scaffold materials, scaffold fabrication methods, cells and signaling molecules, tissue engineering of bone, cartilage, liver, skeletal muscle.

Total Hours: 45

TEXT BOOK

1. Park J.B and Lakes R.S, "Biomaterials", Springer Publications, 3rd Edition, 2007.

REFERENCES

1. Park J.B., Bronzino.D.J, "Biomaterials: Principles and applications", CRC Press, 2002.
2. Qizhi Chen George Thouas, "Biomaterials - A basic introduction", CRC Press, 2012.

20CH2E51 NANO MATERIALS FOR ENERGY AND ENVIRONMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Summarize the importance of nanotechnology in energy extraction.	PO1
CO2:	Make use of the applications of nanomaterials in energy storage devices.	PO1
CO3:	Utilize the nanomaterials in solving environmental problems.	PO1,PO7
CO4:	Outline the environmental impacts of nanomaterials.	PO1,PO7

NANO MATERIALS FOR ENERGY **10**

Introduction -Importance of nanotechnology -Emergence of nanotechnology -Bottom-up and Top- down approaches -Nanomaterials for energy -Sustainable energy production using renewable energy sources -Nanotechnology enabled renewable energy technologies -Energy measures and challenges -Energy transport, conversion and storage.

DEVICE APPLICATIONS **15**

Nanotechnology for sustainable energy -Catalytic reactors Metal nanocluster catalysts for coal liquefaction -Nanomaterials for energy conversion: Materials for light emitting diodes -Solar cells: Thin film silicon solar cells, Hybrid nano-polymer solar cells -Energy conversion: Nanomaterials in fuel cells -Polymer membranes for fuel cells, acid/ alkaline fuel cells -Design of fuel cells -Carbon nanotubes for energy storage -Hydrogen storage in carbon nanotubes -Energy storage: Batteries -MWNT for Li ion batteries -Advanced super capacitors -Use of nanoscale catalysts to save energy and increase the industrial productivity.

NANOMATERIALS FOR ENVIRONMENT **10**

Nanomaterials for environmental remediation -Green nanotechnology and its principles -Photocatalysis -Water purification using nanomaterials -Desalination of water -Solid waste removal -Environmental aspects of energy utilization -Porous materials to store clean energy gases -Metal organic frame works (MOFs) -Storage of carbon dioxide -Methane and hydrogen in MOFs -Nanomaterials and sustainability: agriculture, water, energy, materials and clean environment.

ENVIRONMENTAL IMPACTS OF NANOMATERIALS **10**

Potential impacts of nanomaterials on organisms and ecosystems -Nanotoxicology: Introduction to nanomaterial toxicity -Environmental and health impacts -Biomagnification -Nanoparticles exposure assessment -Toxicity of inhaled nanomaterials -Cytotoxicity induced by nanomaterials -Ethical, legal, and societal implications of nanotechnology.

Total Hours: 45

TEXT BOOKS

1. Robert K, Ian H, Mark G, "Nanoscale Science and Technology", 1st Edition, John Wiley & sons Ltd., 2005.
2. Loucas Tsakalakos, "Nanotechnology for Photovoltaics" 1st Edition, CRC Press, 2010.

REFERENCES

1. Jingbo Liu, Sajid Bashir, "Advanced Nanomaterials and their applications in Renewable energy", 1st Edition, Elsevier, 2015.
2. Challa S.S.R. Kumar, "Nanomaterials: toxicity, health and environmental issues", 1st Edition, Wiley-VCH, 2006.
3. Nelson Durán,Silvia S Guterres, Oswaldo Luiz Alves, "Nanotoxicology: Materials, Methodologies, and Assessments", 1st Edition, Springer, 2014.

WEB REFERENCES

1. https://nptel.ac.in/courses/112/107/112107283
2. https://nptel.ac.in/courses/118/104/118104008
3. https://nptel.ac.in/courses/117/108/117108047

20CH2E52 GREEN CHEMISTRY FOR ENGINEERS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Recall the principles and metrics of green chemistry.	PO1, PO7
CO2:	Summarize the different types of waste and its minimization techniques.	PO1, PO7
CO3:	Outline the various methods of environmental protection.	PO1,PO7
CO4:	Make use of principles of green chemistry in synthesis of materials and energy utilization.	PO1,PO7

PRINCIPLES OF GREEN CHEMISTRY **5**

Green Chemistry -The twelve principles of green chemistry and green engineering with examples -Green chemistry metrics -Atom economy, E factor, reaction mass efficiency and other green chemistry metrics -Application of green metrics analysis to synthetic plans.

WASTE MINIMIZATION **15**

Waste - Sources of waste -Different types of waste -Chemical, physical and biochemical methods of waste minimization and recycling -Designing green processes -Safe design, process intensification, in-process monitoring -Safe product and process design -Environmental load of product -Material selection, resource use, production requirements and planning for the final disposition (recycling, reuse, or disposal) of a product -Design for degradation -Real-time Analysis for pollution prevention -Inherently safer chemistry for accident prevention.

ENVIRONMENTAL PROTECTION **10**

Pollution -Chemical pollution and environmental regulations -Pollution prevention strategies -Challenges to the sustainability of chemical industry -Toxicity of chemicals -Material safety data sheet (MSDS) -Concept of zero pollution technologies -Functional toxicity vs non-functional toxicity -Alternative solvents -Energy minimization -Microwave and sonochemical reactions -Renewable feed stock -Carbon dioxide as a feed stock.

GREEN SYNTHESIS AND GREEN ENERGY **15**

Metal and metal oxide nano particles -Green synthesis of metal nano particles -Greener strategies in phase behaviour and solvent attributes of supercritical CO2 -Use of supercritical carbon dioxide as a medium in chemical industry.

Synthesis of various chemicals from bio mass -Polycarbonate synthesis and CO2 fixation -Green plastics.

Green energy: Renewable energy -Carbon dioxide capture and its chemical recycling to fuels -Integration with existing product design approaches such as quality, producibility, functionality and upgradability.

Eco-labeling -Applications in pharmaceuticals, foods, cosmetics, packaging, computers, polymers, automobiles, electronics industry.

Total Hours: 45

TEXT BOOKS

1. Mike Lancaster, "Green Chemistry -An introductory text", 3rd Edition, RSC publishing, 2016.
2. Alexei Lapkin, David J. C. Constable, "Green Chemistry Metrics: Measuring and Monitoring Sustainable Processes" 1st Edition, Wiley publications, 2008.

REFERENCES

1. C. N. R. Rao, Achim Müller, Anthony K. Cheetham, "Nanomaterials Chemistry - Recent Developments and New Directions" 1st Edition, Wiley-VCH, 2007.
2. Thomas F. McGowan, Michael L. Brown, William S. Bulpitt, James L. Walsh Jr, "Biomass and alternate fuel systems" 1st Edition, Wiley AICHE, 2010.
3. Bela Torok, Timothy Dransfield, "Green Chemistry", 1st Edition, Elsevier, 2017.

WEB REFERENCES

1. https://www.acs.org/content/acs/en/greenchemistry/principles/12-principles-of-green- chemistry.html
2. https://www.epa.gov/greenchemistry/basics-green-chemistry
3. https://nptel.ac.in/courses/105/106/105106056

20CH2E53 ANALYTICAL CHEMISTRY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the principle of UV/Visible spectroscopy in identifying the functional groups.	PO1
CO2:	Make use of the principle of IR spectroscopy in characterisation of chemical compounds.	PO1
CO3:	Identify the type of chromatography for separation of compounds.	PO1

UV AND VISIBLE SPECTROSCOPY **10**

Introduction -Fundamental laws of spectroscopy -Origin of UV/visible spectra -Validity of Beer-Lambert's law -Formation of absorption bands -Types of electronic transitions -Chromophores -Auxochromes -Absorption and intensity shifts -Solvent effects -Selection rules -Interaction of radiation with matter -Qualitative analysis -Identification spectra and structure -Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments.

IR SPECTROSCOPY **15**

Introduction -Theory of molecular vibrations -Vibrational frequency -Factors influencing vibrational frequencies -Finger print region -Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instruments -Sampling techniques -Selection rules -IR spectra of diatomic molecules -Structural information derived from vibrational spectra -Vibrations of polyatomic molecules -Group frequencies -Effect of hydrogen bonding (inter and intramolecular) and substitution on vibrational frequencies -Applications of IR spectroscopy.

CHROMATOGRAPHY **20**

Introduction -Classification of chromatographic methods -Principles of differential migration adsorption phenomenon -Nature of adsorbents -Solvent systems. Types of chromatography: Two dimensional chromatography -Applications -Thin layer Chromatography (TLC) -Principles -Factors effecting Rf values -Advantages -Applications -Column Chromatography -Principles -Separation technique -Importance of column technology (packing, capillaries) -Applications -HPLC -Principles -Applications.

Separation techniques: Gas chromatography -Liquid chromatography -Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field) -Supercritical fluids -Detection: Simple vs specific (gas and liquid) -Electrophoresis (plates and capillary) -Application - DNA analysis.

Total Hours: 45

TEXT BOOKS

1. Mahinder Singh, "A Textbook Of Analytical Chemistry: Instrumental Techniques", 1st Edition, Dominant Publishers, New Delhi, 2006.
2. Gary D. Christian, "Analytical Chemistry", 6th Edition, John Wiley and sons. Inc., New York, 2004.

REFERENCES

1. Raymond PW Scott, "Techniques and practice of Chromatography", 1st Edition, Marcel Dekker Inc. New York, 1995.
2. Frank A Settle, "Hand Book of Instrumental Techniques for Analytical Chemistry, 1st Edition, Prentice Hall, New Jersey, 1997.
3. Gopalan.R, Subramaniam P.S. and Rengarajan K., "Elements of Analytical Chemistry", 2nd Edition, Sultan Chand and Sons, 2003.

WEB REFERENCES

1. https://nptel.ac.in/content/storage2/courses/103108100/module7/module7.pdf
2. https://nptel.ac.in/content/storage2/courses/103108100/module2/module2.pdf
3. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/infrared/infrared.htm

20CH2E54 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Summarize the types of pollution and its control measures.	PO1, PO7
CO2:	Illustrate the strategies of ecosystem and biodiversity.	PO1, PO7
CO3:	Outline the resource management systems and measures for sustainable development.	PO1, PO7

ENVIRONMENTAL DEGRADATION **15**

Introduction -Pollution -Causes, effects and control measures for air pollution, water pollution and soil/land pollution -Climate change -Global warming -Ozone depletion -Pollution control norms -Environment Impact Assessment (EIA) -Environment Management Plan (EMP) -Carbon foot print -Carbon trading.

Field study: Visit to solar power plant.

ECO SYSTEM AND BIO DIVERSITY **15**

Ecosystem: Introduction -Structure and function of an eco system -Ecological succession -Food chain and food web -Types of ecosystem -Terrestrial and aquatic ecosystem.

Biodiversity: Introduction -Genetic, species and ecosystem diversity -Biogeographical classification of India -Values of biodiversity -Biodiversity at global, national and local levels -India as mega diversity nation -Hot-spots of biodiversity -Threats in biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts -Red Data Book -Endangered and endemic species of India -Conservation of biodiversity.

RESOURCE MANAGEMENT SYSTEMS AND SUSTAINABILITY **15**

Resource management systems: Linear and cyclical -Circular economy -Industrial ecology -Zero discharge system -Green technology: Applicable to water resources, energy resources -Energy footprint -Waste management -Hazardous and solid waste management -E-waste management -Green computing.

Sustainability: Need for sustainable development -Need for environmental education -Environmental Ethics -Holistic value-based education for true sustainability.

Field study: Visit to Sewage treatment plant, Solid waste management.

Total Periods: 45

TEXT BOOKS

1. Anubha Kaushik and Kaushik C. P., "Environmental Science and Engineering", 4th Multicolour Edition, New Age International Pvt. Ltd., 2014.
2. Miller T.G.Jr.,"Environmental Science", 4th Edition, Pearson Education, 2015.

REFERENCES

1. Linda D Williams, "Environmental Science, Demystified", 1st Edition, Tata McGraw-Hill, 2005.
2. Rajagopalan R., "Environmental Studies: From Crisis to Cure", 1st Edition, Oxford University Press, 2011.
3. Daniel D Chiras, "Environmmental Science", 1st Edition, Jones and Bartlett Publishers, 2012.

WEB REFERENCES

1. http://nptel.ac.in/courses/104103020
2. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ge22

20CE2E51 WASTE MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of this course, students will be able to

CO1 :	Describe the sources, effects and legislation of municipal solid waste management.	PO1, PO6, PO7
CO2 :	Outline the classification, Handling and treatment techniques of Hazardous waste.	PO1, PO6, PO7,PO11
CO3 :	Discuss the sources, types and disposal techniques of biomedical waste.	PO1, PO6, PO7,PO11
CO4 :	Interpret the sources, effects and management technologies of E-waste.	PO1, PO6, PO7,PO11
CO5:	Analyse the various aspects of Waste to Energy Management Systems.	PO1,PO2, PO6, PO7,PO11

MUNICIPAL SOLID WASTE MANAGEMENT **9**

Definitions and classification of solid wastes - Waste generation - Factors affecting generation - Objective of solid waste management - Effects of improper disposal of solid wastes - Functional Elements - Hierarchy of Waste Management - Waste minimization - Disposal techniques - Relevant Regulations in waste management - LCA of waste management.

HAZARDOUS WASTE MANAGEMENT **8**

Definition - Identification and classification - Hazardous Waste Management and Handling Rules - Source reduction of hazardous wastes - Handling and storage of Hazardous wastes - Waste treatment technologies: Solidification - Chemical fixation - Encapsulation - Incineration - Advanced treatment.

BIOMEDICAL WASTE MANAGEMENT **9**

Sources - Generation - Classification - Storage - Transportation - Waste Treatment and disposal: Autoclave treatment, hydroclave treatment, microwave treatment and chemical disinfection - Advanced treatment - Sanitary and secured land filling.

e -WASTE MANAGEMENT **7**

e-waste - sources - Classification and composition - Characteristics - Environmental and public health issues - Hazardous due to improper disposal - Treatment technologies - Recycle and recovery - Regulatory framework in India.

WASTE TO ENERGY **12**

Biochemical Conversion: Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion: Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies. Landfill gas, collection and recovery. Refuse Derived Fuel - fluff, briquettes, and pellets. Alternate Fuel Resource - Cement plants, Thermal power plants and Industrial boilers. Energy from Plastic Wastes - Non-recyclable plastic wastes for energy recovery.

Total Hours: 45

CASE STUDIES

1. Success and failures of waste to energy
2. Global Best Practices in Waste to energy production distribution and use.
3. Indian Scenario on Waste to Energy production distribution and use in India.

4. Success and Failures of Indian Waste to Energy plants.
5. Role of the Government in promoting 'Waste to Energy'

TEXT BOOKS

1. George Tchobanoglous, Hilary Theisen and Samuel Vigil., "Integrated Solid Waste Management: Engineering, Principles and Management issues", 5th Edition, McGraw Hill Publishers, 2014
2. Manual on Municipal Solid waste Management, CPHEEO, Ministry of Urban Development, Govt. of. India, New Delhi, 2000.
3. Ronald E. Hester and Roy M. Harrison, "Electronic waste management", 1st Edition, Royal society of chemistry, 2009.

REFERENCES

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. Georges E. Ekosse, Rogers W'O Okut-Uma, Pollution control & Waste management in Developing Countries, Commonwealth Publishers, New Delhi, 2000.

WEB REFERENCES

1. Municipal solid waste management https://nptel.ac.in/courses/105/103/105103205/
2. Integrated waste management for smart city https://nptel.ac.in/courses/105/105/105105160/
3. Solid and hazardous waste management https://nptel.ac.in/courses/105/106/105106056/
4. Electronics waste management: Issues and Challenges https://nptel.ac.in/courses/105/105/105105169/
5. Ministry of new and renewable energy - https://www.mnre.gov.in/
6. Industrial waste in India - http://www.eai.in/ref/ae/wte/typ/clas/india_industrial_wastes.html
7. Central pollution control board - http://www.cpcb.nic.in/

20CE2E52 GLOBAL WARMING AND CLIMATE CHANGE 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Describe the evidence for anthropogenic causes of climate change and the relevant scientific uncertainties of global warming.	PO1, PO7
CO2:	Illustrate the impacts of climate change and formulate corrective measures for mitigating the effects.	PO3, PO7
CO3:	Apply quantitative analysis of climate change phenomenon and develop energy balance models.	PO5, PO11
CO4:	Summarize the outcomes of past national and international efforts to address climate change for sustainable global management	PO7

EARTH'S CLIMATE SYSTEM **15**

Atmosphere - weather and Climate - climate parameters -Global ocean circulation - El-Nino and its effect - Carbon cycle- Earth's climate machine -Role of ozone in environment-Ozone layer Ozone depleting gases, Green House Gases(GHG)-Green House Effect, Radiative effects of Greenhouse Gases-Global Warming-Carbon Cycle-Energy balance model with GHGs.

IMPACTS OF CLIMATE CHANGE **10**

Causes of Climate change - Change of Temperature in the environment-Melting of ice (Pole)- Sea level rise-Impacts of Climate Change on various sectors-Agriculture, Forestry and Ecosystem-Water Resources Human Health - Industry, Settlement and Society-Method sand Scenarios Projected Impacts for Different Regions-Uncertainties in the Projected Impacts of Climate Change-Risk of Irreversible Changes.

INTERNATIONAL AGREEMENTS **10**

Climate change and Carbon credits - CDM - Initiatives in India - Kyoto Protocol-Inter governmental Panel on Climate change - Climate Sensitivity and Feedbacks -The Montreal Protocol - UNFCCC - IPCC - Climate change from national perspectives - cost-benefit analysis of climate change issues.

MITIGATION MEASURES **10**

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel-Natural Compost - Eco-Friendly Plastic - Alternate Energy - Hydrogen - Bio-fuels-Solar Energy-Wind Hydroelectric Power Mitigation Efforts in India and Adaptation funding, Case studies on Key Mitigation Technologies and Practices.

Total Hours: 45

TEXT BOOKS

1. Dash Sushil Kumar, "Climate Change-An Indian Perspective ", Cambridge University Press India Pvt. Ltd., 2013.
2. Adaptation and mitigation of climate change Scientific Technical Analysis, Cambridge University Press, 2017.
3. John Houghton, Global Warming: The Complete Briefing, 5th Edition, Cambridge Univ. Press, 2015.

REFERENCES

1. J.M.Wallace and P.V.Hobbs," Atmospheric Science", Elsevier/Academic Press 2016.
2. JanC.van Dam," Impacts of Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2015.

WEB REFERENCES

1. http://www.nptelvideos.com/lecture.phpid=850
2. https://nptel.ac.in/courses/119/102/119102007/

20CE2E53 GEOGRAPHICAL INFORMATION SYSTEM 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify the fundamentals of geographical information system and its components.	PO1, PO2
CO2:	Interpret the spatial data model and input methodology to analyze the spatial data.	PO1, PO2
CO3:	Examine the importance of raster and vector analysis of data and data quality.	PO1, PO2
CO4:	Categorize the Application of GIS based on the societal needs.	PO2, PO5
CO5:	Create GIS based application map using open-source software.	PO2, PO5

FUNDAMENTALS OF GIS **8**

Introduction to GIS - Basic spatial concepts - Datum - Coordinate Systems -GIS - Definitions - Components of GIS: Hardware, Software, Data, People, Methods - open source Software - Types of data - Spatial, Attribute data- Types of attributes - Scales/ levels of measurements.

SPATIAL DATA MODELS **8**

Database Structures - Relational, Object Oriented - Entities - ER diagram - Spatial data models - Raster Data Structures - Raster Data Compression - Vector Data Structures - Raster Vs Vector Models- TIN and GRID data models.

DATA INPUT AND TOPOLOGY **9**

Scanner - Raster Data Input - Raster Data File Formats - Geo-Referencing - Vector Data Input -Digitizer - Topology - Adjacency, connectivity and containment - Topological Consistency - Non topological file formats -Attribute Data linking - Linking External Databases - GPS Data Integration - GPS based map.

DATA QUALITY AND ANALYSIS **12**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage - Metadata. Import/Export - Data Management functions. Vector Data Analysis tools - Data Analysis tools - Network Analysis - Digital Elevation models - 3D data collection and utilization. Raster Data Analysis tools -Spatial Analyst - Raster Calculator. Raster to Vector and Vector to Raster Conversion

APPLICATIONS OF GIS **8**

Natural Resource Management - Engineering - Navigation - Vehicle tracking - Marketing and Business applications- Land Use Land Cover (LULC) Zonation map - Disaster vulnerability map - Generation of Map using open source GIS software.

Total Hours: 45

TEXT BOOKS

1. Kang-Tsung Chang, Introduction to Geographic Information Systems, 2nd Edition, Mc-Graw Hill Publishing, 2011.
2. Lillesand, Kiefer, Chipman, "Remote Sensing and Image Interpretation", Wiley, Sixth edition, 2011.

REFERENCES

1. Peter A. Burrough, Rachael A. McDonnell, Christopher D. Lloyd, "Principles of Geographical Information Systems" Oxford University Press; International 3rd edition, 2016.
2. John D. Bossler, "Manual of Geospatial Science and Technology", CRC Press; 2nd edition, 2020.

WEB REFERENCES

1. http://www.nptelvideos.in/2012/11/modern-surveying-techniques.html
2. https://nptel.ac.in/courses/105/108/105108077/
3. https://nptel.ac.in/courses/105/103/105103193/

20CE2E54 DISASTER MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Define the basic terms of disaster and disaster management cycle.	PO1
CO2:	Interpret the remedial measurements for natural and human induced disaster.	PO1
CO3:	Examine the significance of disaster management to reduce the impact.	PO1
CO4:	Infer the advanced technology usage in disaster mitigation process.	PO2, PO5
CO5:	Develop the disaster-prone area map using open-source software.	PO5, PO11

DISASTERS **9**

Meaning, Nature, Importance of Hazard, Risk, Vulnerability and Disaster -Classification: Natural and Man-made-Technological, Miscellaneous Accidents. Dimensions & Scope of Disaster Management-Vulnerabilities - National disaster management framework - Disaster Management Cycle

NATURAL DISASTER **9**

Natural Disasters- Meaning and nature of natural disaster: Major natural Disasters: Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions - Climatic change: global warming, Sea level rise, ozone depletion.

HUMAN INDUCED DISASTER **6**

Human Induced Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, Terrorism, oil spills.

DISASTER MANAGEMENT **9**

Pre- disaster stage (preparedness) - Risk Management- Risk identification, risk reduction (planning, prevention, mitigation, preparedness)- risk transfer- Emergency Stage - Rescue training for search & operation - Immediate relief. Post Disaster stage - Rehabilitation - Social Aspect - Economic Aspect and Environmental Aspect.

DISASTER MITIGATION **12**

Meteorological observatory - Seismological observatory - Hydrology Laboratory and Industrial Safety inspectorate -Technology in Disaster Management -Emergency Management Systems (EMS) in the Disaster Management Cycle - Remote Sensing and Geographic Information Systems (GIS) in Disaster Management -Case studies on disaster management in India.

Total Hours: 45

TEXT BOOKS

1. Sharma.S.R, "Disaster management", A P H Publishers, 2011
2. Hyndman.D and Hyndman.D "Natural Hazards and Disasters" Cengage Learning, Inc, 3rd Edition, 2011.

REFERENCES

1. Johnson.C. Creating an enabling environment for reducing disaster risk: Recent experience of regulatory frameworks for land, planning and building in low and middle-income countries. Global assessment report on disaster risk reduction. ISDR, April 2011.
2. VenuGopalRao.K, "Geoinformatics for Disaster Management", Manglam Publishers and Distributors, 2010
3. Singh.R.B, "Natural Hazards and Disaster Management: Vulnerability and Mitigation", Rawat Publications, 2006.
4. NDMA. (2019). National Disaster Management Plan, NDMA: New Delhi

WEB REFERENCES

1. https://nptel.ac.in/courses/105/104/105104183/
2. https://nptel.ac.in/courses/124/107/124107010/
3. https://nptel.ac.in/courses/127/106/127106004/

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify suitable technology for the prevention of industrial pollution.	PO1
CO2:	Illustrate waste and energy audit process	PO1, PO2
CO3:	Summarize the Environmental management laws pertaining to Industrial Pollution as per ISO 14001.	PO1
CO4:	Infer the risk factor in an Industrial project and draft a report.	PO1,PO2,PO7
CO5:	Outline the cleaner technologies adopted in different Industries.	PO1, PO2

INDUSTRIAL WASTE, TYPES AND ITS CONTROL 11

Nature and characteristics of industrial wastes - Prevention versus control of industrial pollution- Linkage between technology and pollution prevention - Tools for clean processes, reuse, recycle, recovery, source reduction, raw material substitution-toxic use reduction and process modifications.

ENERGY AND WASTE AUDIT 9

Unit operations in separation technology - Separation technologies as tools for waste minimization- process optimization for cleaner industrial processes- Flow sheet analysis- Energy and resource (material and water) audits for efficient usage and conservation -Waste audits, emission inventories and waste management hierarchy for process industries - Protocol for conducting environmental audit.

ENVIRONMENTAL MANAGEMENT SYSTEM 10

EMAS, ISO 14000 - EMS as per ISO 14001:2015- benefits and barriers of EMS - Concept of continual improvement and pollution prevention - environmental policy - environmental aspect and impact analysis - legal and other requirements- objectives and targets - environmental management programs - Roles and responsibilities of environment managers - sustainability reporting as per GRI G4 guidelines- communication - documentation- operational control - monitoring and measurement - management review.

ENVIRONMENTAL REGULATIONS AND RISK ASSESSMENT 9

Environmental regulations and policies- Environmental protection laws and acts- Environment and forest clearance Procedures - Corporate and international charters and protocols - Risk assessment - Environmental impact assessment - Industrial ecology - Pollution prevention -Waste minimization and sustainable development- Life cycle assessment - Eco-labelling of products.

CASE STUDIES 6

Case studies on industrial applications of cleaner technologies in chemical, metallurgical, pulp and paper, textile, electroplating, leather, dairy, cement and other industries.

Total Hours: 45

TEXT BOOKS

1. Tapas K. Das, Industrial Environmental Management: Engineering, Science, and Policy, Wiley, 2020.
2. I.V Murali Krishna ValliManickam, Environmental Management Science and Engineering for Industry, Butterworth-Heinemann, 2017.

3. R. Sullivan, Hugh, Wyndham, Effective Environmental Management: Principles and Case Studies, Allen & Unwin Academic, 2001.

4. C. J. Barrow, Environmental Management: Principles and Practice (Routledge Environmental Management Series) Routledge, 1st edition, 1999.

REFERENCES

1. F. B. Friedman, Practical Guide to Environmental Management, Environmental Law Institute, USA, 9th edition 2003.

2. G. Burke, Ben R. Singh and L. Theodore, Handbook of Environmental Management and Technology, Wiley-Inderscience, 2nd edition, 2000.

3. B. Taylor, Effective Environmental, Health, and Safety Management Using the Team Approach, Wiley-Inderscience, 2005.

4. D. L. Goetsch and S. B. Davis, ISO 14001: Environmental Management, Prentice Hall, 2000.

WEB REFERENCES

1. https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-oe02/

2. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ge22/

ENLIGHTENMENT THROUGH EDUCATION SREC

20CE2E56 **REMOTE SENSING AND GIS FOR URBAN PLANNING AND MANAGEMENT** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Relate the basic concepts of remote sensing techniques in detecting urban features.	PO1,PO2,PO3,PO5,PO6,PO7,PO8
CO2:	Discuss the urban change detection using feature extraction Sprawl detection techniques.	PO1,PO2,PO3,PO5,PO6,PO7,PO8
CO3:	Identify the formulation of land suitability and network alignment using remote sensing and GIS.	PO1,PO2,PO3,PO5,PO6,PO7,PO8
CO4:	Analyze the web applications in the modelling of urban growth.	PO1,PO2,PO3,PO5,PO6,PO7,PO8

INTRODUCTION **9**

Definition of Remote sensing, Components of Remote sensing- Energy interaction with atmosphere - Spectral signatures of vegetation, Soil and Water-Spatial and non-spatial Data- - Remote sensing for detection of urban features – Scope and limitations – Urban Land use Classification – Visual and Digital Techniques for Land use Mapping.

URBAN MAPPING **9**

Urban Area Definition and Characterization–Base Map Preparation – Urban Structure and Patterns– Urban Land Cover Classification –Feature Extraction techniques –Change Detection – Sprawl Detection and Characterization - Mapping of Urban Morphology - Urban Heat Island –Building Typology

GEOMATICS FOR URBAN PLANNING **9**

Urban morphology – Housing typology – Population estimation from remote sensing – Infrastructure demand analysis – Urban renewal Land suitability analysis – Plan formulation – Regional, Master and detailed development – Use of remote sensing and GIS in plan preparation – Urban information system.

GEOMATICS FOR TRANSPORTATION PLANNING **9**

Mapping transportation network – Classification – Optimum route- Alignment planning – Traffic and parking studies – Case studies on Accident analysis.

VISUALIZATION, SIMULATION AND MODELING OF URBAN AREAS **9**

Urban Growth Modelling - Air quality indexing and mapping - Noise pollution modelling - Flood Modeling in Urban Areas -Recent Advancements - Case Studies on Applications of LIDAR-3D City Modelling.

Total Hours: 45

TEXT BOOK:

1. Soergel, Uwe (Eds.), Radar Remote Sensing of Urban Areas, Remote Sensing and Digital Image Processing, Vol. 15, 1st Edition, Springer, 2010.
2. BasudebBhatta, Analysis of Urban Growth and Sprawl from Remote Sensing Data, 1st Edition, Springer-Verlag, 2010

REFERENCES:

1. QihaoWeng, Dale A. Quattrochi (Eds), Urban Remote Sensing, 2nd edition, CRC Press, 2018
2. Rashed, Tarek; Jurgens, Carsten (Eds.), Remote Sensing of Urban and Suburban Areas, Springer, 1st Edition. 2010
3. Netzband, Maik; Stefanov, William L.; Redman, Charles (Eds.), Applied Remote Sensing for Urban Planning, Governance and Sustainability, Springer, 1st Edition, 2007
4. Jean-Paul Donnay, Michael John Barnsley, Remote sensing and urban analysis, 1st Edition, Taylor & Francis e-Library, 2005

WEB REFERENCE

1. https://nptel.ac.in/courses/105/105/105105202/
2. https://nptel.ac.in/courses/105/103/105103193/

20CE2E57 HABITAT SUSTAINABILITY 3 0 0 3

COURSE OUTCOMES
On successful completion of the course, the students will be able to

CO1	Identify various environmental hazards	PO1,PO2,PO3,PO6,PO7
CO2	Understand the various methods of conservation of resources	PO1,PO2,PO3,PO6,PO7
CO3	Formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects	PO1,PO2,PO3,PO6,PO7
CO4	Summarize the impact of human population change. Environmental Impact Assessment	PO1,PO2,PO3,PO6,PO7
CO5	Outline the impact of pollution at the global level as well regional level on the environment.	PO1,PO2,PO3,PO6,PO7

Environmental Quality and Hazards 9
Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution.Water quality management and its conservation. Solid and hazardous waste – types and waste management methods-Diaster Management

Energy Resources 9
Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar- Hydrogen revolution.

Environmental Impact Assessment 9
Introduction to environmental impact analysis.EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life).Impact assessment methodologies.Public awareness.Environmental priorities in India.

Human Population Change and Environment 9
Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment.Sustaining human societies: Economics, environment, policies and education.

Global Climatic Change and Mitigation 9
Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information

Text Books

1. G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.
2. George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.
3.John Houghton, Global Warming: The Complete Briefing, 5th Edition, Cambridge Univ. Press, 2015.

Reference Books

1.David M. Hassenzahl, Mary Catherine Hager, Linda R. Berg (2011), Visualizing Environmental Science, 4th Edition, John Wiley & Sons, USA.
2.Canter R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
3.J.M.Wallace and P.V.Hobbs," Atmospheric Science", Elsevier/Academic Press 2016.

Web References:

1. https://nptel.ac.in/courses/120/108/120108004/
2.http://www.nptelvideos.com/lecture.phpid=850
3. https://nptel.ac.in/courses/119/102/119102007/

ENLIGHTENMENT THROUGH EDUCATION SREC

16CE2E58 OCCUPATIONAL HEALTH AND SAFETY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Incorporate the health and safety systems by the legal code and practice	PO1,PO2,PO5,PO6,PO7,PO8,PO12
CO2	Categorize and monitor the health hazards and risks	PO1,PO2,PO5,PO6,PO7,PO8,PO12
CO3	Implement satisfactory and safe design of work premises	PO1,PO2,PO5,PO6,PO7,PO8,PO12
CO4	Assess the plant safety and control techniques	PO1,PO2,PO5,PO6,PO7,PO8,PO12
CO5	Understand the Environmental health and safety management	PO1,PO2,PO5,PO6,PO7,PO8,PO12

INTRODUCTION **9**

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place

OCCUPATIONAL HEALTH AND HYGIENE **9**

Definition of the term occupational health and hygiene - Yoga and Occupational Health- Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress- methods of health safety.

WORKPLACE SAFETY AND SAFETY SYSTEMS **9**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety- Applications and the method of roof line safety, cross barrier safety,

HAZARDS AND RISK MANAGEMENT **9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT **9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation- Case studies-Contemporary issues.

Total Hours: 45

TEXT BOOKS:

S.K.Haldar ,Industrial and Occupational Health, CBS Publishers and Distributers Pvt Ltd,2017.
S.Z. Mansdorf,Handbook of Occupational Safety and Health, Third Edition,2019.
Charles D.Reese,Occupational Health and Safety Management: A Practical Approach,CRC Press,2018.

REFERENCES:

1. Bill Taylor, Effective Environmental, Health, and Safety Management Using the Team Approach by Culinary and Hospitality Industry Publications Services, 2010.
2. Brian Gallant, The Facility Manager's Guide to Environmental Health and Safety by Government Inst Publ., 2017.
3. Mistry K U, SiddharthPrakashan, Fundamentals of Industrial Safety and Health by 2012
4. Nicholas P. Cheremisinoff and Madelyn L. Graffia, Environmental and Health and Safety Management by William Andrew Inc. NY, 2015

WEB REFERENCES :

1. https://nptel.ac.in/courses/110/105/110105094/
2. https://nptel.ac.in/noc/courses/noc15/SEM1/noc15-oe02/
3. https://onlinecourses.nptel.ac.in/noc21_ce16/

20CS2E61 **PYTHON FOR DATA SCIENCE** **3 0 0 3**

COURSE OUTCOMES:

On successful completion of the course, the students will be able to

CO1:	Recall the basic concepts of Python Programming.	PO1, PO2, PO12
CO2:	Explain the the fundamentalsfor data cleaning and processing in Python.	PO1,PO2, PO4, PO5, PO12
CO3:	Apply various operations working in python for the real time scenario.	PO1, PO2,PO3, PO4, PO5, PO12
CO4:	Analyze various data visualization tools for effective interpretations and insights of data.	PO1, PO2,PO3, PO4, PO5, PO12

OVERVIEW OF PYTHON AND DATA STRUCTURES **10**

Basics of Python including data types, variables, expressions, objects and functions. Python data structures including String, Array, List, Tuple, Set, Dictionary and operations them.

WORKING WITH DATA IN PYTHON **10**

Reading Files with Open-Writing Files with Open-Loading Data with Pandas-Pandas: Working with and Saving Data-One Dimensional Numpy-Two Dimensional Numpy- Introduction to Panda's Dataframes-Dataframe Components-Performing Statistics and Calculations on Sliced and Grouped Dataframes-Plotting in Matplotlib

GETTING YOUR HANDS DIRTY WITH DATA **12**

Using the Jupyter Console, Interacting with screen text, Changing the window appearance, Getting Python help, Getting IPython help, Using magic functions, Discovering objects, Using Jupyter Notebook, Working with styles, Restarting the kernel, Restoring a checkpoint, Performing Multimedia and Graphic Integration, Embedding plots and other images, Loading examples from online sites, Obtaining online graphics and multimedia. Case Study: Classification

DATA VISUALIZATION **13**

Choosing the Right Graph-Showing parts of a whole with pie chart-Creating comparisons with bar charts-Showing distributions using histograms-Depicting groups using box plots -Seeing data patterns using scatter plots-Showing correlations -Plotting Time Series -Getting the Base map toolkit-Using Base map to plot geographic data-Visualizing Graphs

Total Periods: 45

TEXT BOOKS

1. "Python for data science for dummies" John Paul Mueller, Luca Massaron, Wiley, July 2015.
2. "Pandas for everyone: Python Data Analysis",Daniel Y. Chen Pearson, 1st Edition, December 2017

REFERENCES

1. Data Science from Scratch: First Principles with Python Joel Grus O'REILLY , 1st Edition, April 2015.
2. Applied Data Science with Python and Jupyter: Use powerful industry-standard tools to unlock new, actionable insights from your data,, Packt ,October 2018.

WEB REFERENCES

1. www.coursera.org/learn/python-for-applied-data-science-ai#syllabus
2. www.takethiscourse.net/python-for-data-science-by-iit/
3. www.anaconda.com
4. www.python.org
5. www.w3schools.com
6. www.learnpython.org

20CS2E62 DATA ANALYTICS 3 0 0 3

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO1:	Understand the basic functionalities of Data Mining Techniques	PO1, PO2, PO3, PO4, PO11, PO12
CO2:	Apply Data Analytics algorithms to the analysis of Business problems	PO2, PO3, PO4, PO11, PO12
CO3:	Apply Algorithms to build Machine Intelligence	PO2, PO3, PO4, PO11, PO12
CO4:	Describe Big Data Analytics Tools	PO2, PO3, PO4, PO5, PO11,PO12
CO5:	Use statistical methods and Visualization to quickly explore Data	PO2, PO3, PO4, PO11, PO12

DATA MINING **9**

Relation To Statistics - Databases - Data Mining Functionalities - Steps in Data Mining Process - Architecture of Typical Data Mining Systems - Classification Of Data Mining Systems - Overview Of Data Mining Techniques.

PREDICTIVE MODELING **12**

Mining Association Rules in Large Databases - Classification and Prediction: Issues Regarding Classification and Prediction - Classification by Decision Tree Induction - Bayesian Classification - Other Classification Methods - Prediction - Clusters Analysis: Types Of Data In Cluster Analysis - Categorization Of Major Clustering Methods.

OVERVIEW OF BIG DATA ANALYTICS **12**

Introduction to Big Data - Big Data Analytics Applications - Time Series Analysis - Introduction to Map Reduce / Hadoop

TECHNOLOGIES AND TOOLS FOR DATA ANALYTICS **12**

Data visualization techniques using R Tool: Histograms - Box plots - Scatter plots - Time series - Spatial Data - Spark - Introduction to Exploratory Data Mining - Association Rule Mining-Clustering and Classification Techniques using WEKA Tool

Total Periods: 45

TEXT BOOKS

1. Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 2011
2. Cathy O'Neil and Rachel Schutt,"Doing Data Science, Straight Talk from the Frontline", O'Reilly, 2014.

REFERENCES

1. AnandRajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2011.
2. Joel Grus, "Data Science from Scratch", Copyright c 2015
3. Tom White, "Hadoop: The Definitive Guide", OReilly Media, 4th Edition, 2015.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/106/110106072/
2. https://nptel.ac.in/courses/106/107/106107220/

20CS2E63 JAVA PROGRAMMING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Interpret Java programs using Object Oriented Concepts.	PO1,PO2,PO3,PO4
CO2	Design Simple Java Applications involving GUI and Threading	PO2,PO3,PO4
CO3	Develop Network based Java Programs with Java Database Connectivity	PO2,PO3,PO4
CO4	Analyze the implementation issues to give better program solutions	PO2,PO3,PO4

INTRODUCTION TO JAVA **9**

Object Oriented Language: Overview - JAVA Environment - Comparing JAVA, C and C++ - Keywords and Operators - Identifiers - Literal - Expressions - Control Statements - Arrays and Strings - Command Line Arguments - Data Members - Methods - Overloading Constructors - Class Assignment - This - Static members and methods - Final - Super keyword - Exception Handling.

INHERITANCE, PACKAGES AND THREADS **9**

Abstract Classes - Inheritance: Types - Single - Multilevel - Hierarchical - Interfaces: Defining - Implementing - Packages: Introduction - Importing packages - Implementation - Multithreaded Programming: Thread model - Creating a Thread - Thread Priority - Synchronization - Inter Thread Communication.

AWT AND APPLET **9**

HTML: Introduction - Webpage Design - Basic Tags - Simple Programs - Applet: Lifecycle - Simple Applet Display - Labels - Text fields - Buttons - Combo Boxes - Passing Parameters to Applet - AWT: Windows Fundamentals - AWT Controls - Event Handling: Sources of Events - Event Delegation Model - Event Classes - Event Listener Interfaces - AWT Classes - Working with Graphics - Working with Color - Working with Font - Layout Managers - Menu Bars and Menus.

JAVA COLLECTION FRAMEWORK AND DATABASE CONNECTIVITY **9**

Java Collection Framework: Vector - List - TreeSet - HashSet - Enumeration - Autoboxing - Annotations - JDBC: Architecture - JDBC Connectivity - Drivers - Setting up a Database - Setting up Tables - Establishing Connection - Getting Data From a Table - Select - Update - Record Sets - Prepared Statements - Callable Statements.

INPUT/OUTPUT STREAMS AND NETWORKING BASICS **9**

Input Output: I/O Classes and Interfaces - The Character Stream - Buffered Reader and Buffered Writer - Serialization - Files - Java and Net: Stream Classes - Socket - Inet Address - URL Connection - TCP/IP Sockets - Datagrams - Simple Client/ Server Program.

Total Periods: 45

TEXT BOOK

1. Herbert Schildt, "The Complete Reference Java", 7th Edition, Tata McGraw- Hill, 2011.

REFERENCE

1. E. Balaguruswamy, "Programming with Java", 4th Edition, Tata McGraw-Hill, 2007.

WEB REFERENCE

1. https://nptel.ac.in/courses/106/105/106105191/

20CS2E64 MACHINE LEARNING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the foundations of Artificial Intelligence & Machine Learning	PO2, PO3, PO4, PO11, PO12
CO2:	Analyze the Supervised learning	PO2, PO3, PO4, PO11, PO12
CO3:	Analyze the Reinforcement Learning	PO2, PO3, PO4, PO11, PO12
CO4:	Understand other Learning approaches in Machine Learning	PO2, PO3, PO4, PO11, PO12

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING 12

Definition of learning systems, Goals and applications of machine learning, Probability theory, Computational probability, Statistical decision theory, Learning versus design, Feasibility of learning, Training versus testing, Labeled versus unlabeled dataset, Error, Noise, Theory of generalization, Hypothesis class, Vapnik-Chervonenkis (VC) dimension, Bias, Variance, Learning curve, Data preprocessing, Model selection, Under-fitting and over-fitting, Cross validation, Concept representation, Function approximation.

SUPERVISED LEARNING 13

Learning a class from examples, Learning multiple classes, Dimensions of a supervised machine learning algorithm,

Discriminant functions, Probabilistic generative models, Probabilistic discriminative models, Logistic regression, Linear regression.

REINFORCEMENT LEARNING 10

Model-free reinforcement learning:Q Learning, Algorithm for learning Q, Convergence, Updating sequences strategies, Model based learning: Value iteration-Policy iteration,K-Armed bandit - elements.

OTHER LEARNING APPROACHES 10

Clustering, Expectation maximization (EM) for soft clustering, Semi-supervised learning with EM using labeled and unlabeled data, Ensemble learning: boosting, bagging, Sampling: Basic sampling methods - Markov Chain Monte Carlo.

Total Periods :45

TEXT BOOKS

1. AbuMostafa Y S, MagdonIsmail M and Lin H T, "Learning from Data", AML Book Publishers, USA. 2012.
2. EthemAlpaydm, "Introduction to Machine Learning", PHI Learning Private Limited, New Delhi, 2012.

REFERENCES

1. Tom Mitchell, "Machine Learning", McGraw Hill,USA, 2013.
2. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, USA, 2010.
3. Trevor Hastie, Robert Tibshiraniand Jerome Friedman,"TheElements of Statistical learning", Springer, USA, 2009. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, USA,2012.

WEBREFERENCE

1. https://nptel.ac.in/courses/106/106/106106139/
2. https://nptel.ac.in/courses/106/105/106105152/
3. https://nptel.ac.in/courses/106/106/106106198/

20CS2E65 CYBER SECURITY 3 0 0 3

Course Outcomes:

CO1	Understand the concepts and foundations of computer security	PO2, PO3, PO4, PO11, PO12
CO2	Illustrate various authentication mechanisms.	PO2, PO3, PO4, PO11, PO12
CO3	Identify vulnerabilities of systems and networks.	PO2, PO3, PO4, PO11, PO12
CO4	Develop basic security enhancements in networking environments	PO2, PO3, PO4, PO11, PO12

OVERVIEW **9**

Computer Security Concepts - Threats, Attacks, and Assets - Security Functional Requirements - Fundamental Security Design Principles - Attack Surfaces and Attack Trees- Computer Security Strategy - Cryptographic Tools - Confidentiality with Symmetric Encryption - Message Authentication and Hash Functions - Public-Key Encryption - Digital Signatures and Key Management

USER AUTHENTICATION **9**

Electronic User Authentication Principles - Password-Based Authentication - Token-Based Authentication - Biometric Authentication -Remote User Authentication. Access Control - Access Control Principles - Subjects, Objects, and Access Rights - Discretionary Access Control - Example: UNIX File Access Control - Role-Based Access Control - Attribute- Based Access Control - Identity, Credential, and Access Management

DATABASE AND DATA CENTER SECURITY **9**

The Need for Database Security - Database Management Systems - Relational Databases - SQL Injection Attacks - Database Access Control - Inference Database Encryption -Data Center Security

MALICIOUS SOFTWARE **9**

Types of Malicious Software (Malware) - Advanced Persistent Threat - Propagation-Infected Content-Viruses - Propagation-Vulnerability Exploit-Worms - Propagation-Social Engineering-Spam E-Mail, Trojans - Payload-System Corruption - Payload-Attack Agent-Zombie, Bots - Payload-Information Theft-Keyloggers, Phishing, Spyware - Payload-Stealthing-Backdoors, Rootkits

DENIAL-OF-SERVICE ATTACKS **9**

Denial-of-Service Attacks- Flooding Attacks - Distributed Denial-of-Service Attacks - Application-Based Bandwidth Attacks - Reflector and Amplifier Attacks - Defenses Against Denial-of-Service Attacks - Responding to a Denial-of-Service Attack - Firewalls and Intrusion Prevention Systems - The Need for Firewalls - Firewall Characteristics and Access Policy - Types of Firewalls - Firewall Basing - Firewall Location and Configurations - Intrusion Prevention Systems

Total Periods: 45

TEXT BOOKS

1. William Stallings, Lawrie Brown, "Computer Security: Principles and Practice,Pearson; 4th edition, Global Edition, 2018.
2. Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security: Pearson New International Edition, 2013.

REFERENCES

1. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001
2. William Stallings, Network Security Essentials: Applications and Standards, Pearson, 6th edition, 2017.

WEBREFERENCE

1. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
2. https://nptel.ac.in/courses/106/106/106106129/

20EE2E51 RENEWABLE ENERGY SYSTEMS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the concept of energy consumption, energy scenario, energy sources and their availability	PO1, PO6, PO11
CO2:	Explain the working principle and operation of solar energy conversion technologies, PV arrays and MPPT techniques	PO1, PO6, PO11
CO3:	Discuss the principle of wind energy systems and its types, ocean thermal energy conversion system and Hydel power generation.	PO1, PO6, PO11
CO4:	Summarize the concepts, classification of miscellaneous sources and its applications.	PO1, PO6, PO11

INTRODUCTION AND SOLAR ENERGY CONVERSION **15**

Trends in energy consumption - World energy scenario - Energy sources and their availability - Principle of solar thermal power generation - Low and medium temperature systems - Stirling cycle - Brayton cycle - Solar radiation and measurement-Types of Solar Collectors - Block Diagram of Solar Power Generation System - Solar Water Heating Systems - Solar Pond - Solar cells and their types - Power Conditioners - Charge controllers - PV arrays - Maximum Power Point Tracking - Synchronized Operation with grid supply.

WIND ENERGY SYSTEMS, ENERGY FROM OCEANS **15**

Basic principle of wind energy conversion - Nature of wind - Power in the wind - Components of a wind energy conversion system - Classification of WECS - Performance of Wind Generators - Ocean thermal energy conversion - Basic Rankine Cycle and its Working- Method of ocean thermal electric power generation - Energy from Wave and Tidal - Working principles and operation of different types tidal and wave power generation-Mini, Micro hydel power generation.

MISCELLANEOUS SOURCES **15**

Principle and operation - Types - Efficiency - Effect of Polarization on Efficiency - Construction and Working of H2O2 and Proton Exchange Membrane Fuel Cell - Introduction to Hydrogen Energy Production and Storage - Solar Pond - Magneto Hydro Dynamic Systems - Geo-thermal Energy - Biomass Energy Conversion Technologies- Biogas generation, classification and types of biogas plants.

Total periods: 45

TEXT BOOKS

1. Rao. S and Paruklekar, "Energy Technology - Non Conventional, Renewable and Conventional", Khanna Publishers, 1999.
2. Mukund R. Patel, "Wind and Solar Power Systems", CRC Press LLC, 2006.

REFERENCES

1. Rai G. D, "Non Conventional Energy Sources", Khanna Publishers, 1993.
2. Garg, H. P. and Prakash J., "Solar Energy - Fundamentals and Applications", Tata McGraw Hill, 1997.
3. Shobh Nath Singh, "Non-conventional Energy resources", Pearson Education, 2015.
4. Charles E. Brown, "World Energy Resources", Springer, 2002.

WEB REFERENCES

1. http://nptel.ac.in/courses/108108078
2. https://nptel.ac.in/courses/121106014

CASE STUDY

1. Grid-connected renewable energy systems,
2. Mini-grid renewable energy systems, and
3. Stand-alone renewable energy systems.

20EE2E52 POWER GENERATION SYSTEMS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Illustrate the concept of economics of power generation.	PO1, PO6, PO7, PO11
CO2:	Discuss about the layout and working functions of steam, diesel, and hydro-power plants.	PO1, PO6, PO7, PO11
CO3:	Explain the working principle of nuclear power plants, reactor control and safety	PO1, PO6, PO7, PO11
CO4:	Summarize the concepts, working principles of non-conventional power generation systems.	PO1, PO6, PO7, PO11

ECONOMICS OF POWER GENERATION **12**

Economics of generation - Load duration curve - Load, demand and diversity factors, Plant capacity and plant use factors - Choice of type of generation - Choice of size and number of units - Cost of energy generated - Tariffs-Power factor improvement-Overview of system operation: Load forecasting, techniques of forecasting.

CONVENTIONAL POWER GENERATION **18**

Comparison of power generation systems, layout and working of steam, diesel, low &high head hydro-power plants - Pumped storage plants - Economic operation of steam - Hydro plants -Inter connected operations division of load in interconnected system, economic loading of steam and hydro power plants.

Nuclear power plants - Principle of power generation, location, advantages and disadvantages of nuclear power plants - Reactor control - Reactor safety waste disposal.

NON-CONVENTIONAL POWER GENERATION **15**

Basic concepts, principles of working and layout of Solar Energy Conversion and MPPT techniques, Wind Energy, Tidal and Wave energy, Biomass and Geothermal power generation.

Total periods: 45

TEXT BOOKS

1. Soni, Gupta, Bhatnagar and Chakrabarti, "A text book on Power Systems Engineering", Dhanpat Rai and Sons, 2004.
2. Wadhwa C.L., "Generation, Distribution and Utilization of Electric Energy", 3rd Edition, New Age International Ltd., 2011

REFERENCES

1. Deshpande M.V, "Elements of Electrical Power systems Design", Tata McGraw Hill Publications, 2001.
2. Peter Gevorkian, "Sustainable Energy Systems Engineering", McGraw Hill, 2007.
3. Bent Sorensen, "Renewable Energy, Elsevier", Academic Press, 2011.

WEB REFERENCES

1. http://nptel.ac.in/courses/108108078
2. http://nptel.ac.in/courses/108102047

CASE STUDY

1. Hybrid power plants
2. Indian Energy Scenario
3. Electrical Energy Demand in Rural India

20EE2E53 TROUBLESHOOTING OF ELECTRICAL APPARATUS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the concepts of domestic appliances and Electrical safety.	PO1, PO3, PO4, PO12
CO2:	Interpret types of batteries in UPS	PO1, PO3, PO4
CO3:	Explain the troubleshooting techniques in Mixer Grinder	PO1, PO3, PO4
CO4:	Demonstrate and troubleshoot the problems in washing machine.	PO1, PO3, PO4

DOMESTIC APPLIANCES **15**

Electrical Safety and Protective equipment, Indian Electrical Standards - Working principles and circuits of common domestic equipment's and appliances: Domestic Wiring, Heater / Immersion Heater, Iron Box, Ceiling Fan, Geyser, Concept of Neutral and Earth.

UPS/INVERTER & MIXER GRINDER **15**

Various types of batteries used in UPS - Inverters and their maintenance - Different types of inverter - UPS: Working principle, specifications, explanation with the help of block diagram. Various parts & functions of Mixer/Grinder, speed control circuit & automatic over load protector.

WASHING MACHINE **15**

Different types of machines, washing techniques, parts of manual, semi-automatic and fully automatic machines, basic working principle of manual, semi-automatic and fully automatic machines, study the working of motors, different types of timers, power supply circuits.

Total periods: 45

TEXT BOOKS

1. David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", 1st Edition, McGraw-Hill Education, 2013.
2. Mark Brown, Jawahar Rawtani, Dinesh Patil, "Practical Troubleshooting of Electrical Equipment and Control Circuits", 1st Edition, Newnes Books, 2013.

WEB REFERENCES

1. https://www.apcdistributors.com/white-papers/Power/WP1%20The%20Different%20Types%20of%20UPS%20Systems.pdf

CASE STUDY

Design a prototype model

1. Water Level Indicator
2. Burglar/Theft Alarm
3. Automatic control of home appliances

20EE2E54 ELECTRIC AND HYBRID VEHICLES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the fundamentals of Electric and Hybrid Electric Vehicles	PO1, PO2, PO9, PO10
CO2:	Interpret the parameters and performance of Electric vehicle.	PO1, PO2, PO9, PO10
CO3:	Explain different types of electric motors and power converters	PO1, PO2, PO9, PO10
CO4:	Understand the Indian and global policies and Regulations.	PO1, PO2, PO9, PO10

ELECTRIC AND HYBRID ELECTRIC VEHICLES **15**

History - Components of Electric and hybrid Vehicle - General Layout of EV and hybrid EV - EV classification - Comparison with Internal combustion Engine, Technology, Advantages & Disadvantages of EV and Hybrid EV, Comparison with Electric and hybrid Vehicles - Overview of Toyota prius, Overview of Tesla car.

VEHICLE FUNDAMENTALS **12**

Vehicle resistance - Types: Rolling Resistance, grading resistance - Calculating the acceleration Force, maximum speed - Finding the Total Tractive Effort - Torque Required on the Drive Wheel, - Transmission: Differential, clutch and gear box - Braking performance.

MOTORS AND CONVERTERS **12**

Principle and working of DC motor - Characteristics and Types of DC Motors - Overview (Speed torque characteristics) of Permanent Magnet motor, BLDC Motor, Induction motor - Comparison of all motors - Introduction of DC-DC, AC-AC, AC-DC, DC-AC Converters, four-quadrant operation, Driver circuits.

INDIAN AND GLOBAL SCENARIO **6**

Technology Scenario - Market Scenario - Policies and Regulations - Payback and commercial model - Polices in India

Total Periods: 45

TEXT BOOKS

1. Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", 2th Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

REFERENCE BOOKS

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
2. Keljik J., "Electricity 4: AC/DC Motors, Controls and Maintenance" Clifton Park, NY: Delmar Cengage Learning, 2013.

WEB REFERENCES

1. https://nptel.ac.in/courses/108/103/108103009/#
2. https://nptel.ac.in/courses/107/106/107106080/
3. https://nptel.ac.in/courses/108/106/108106170/

CASE STUDY

1. Simulation of EV using MATLAB/SIMULINK or any other simulation platform.
2. Study on architecture of recent HEVs like Toyota, BMW, Honda, Tesla etc.

20EE2E55 ELECTRICAL MACHINES AND DRIVES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Demonstrate the principle of electromechanical energy conversion and constructional details and operation of DC machine.	PO1, PO2
CO2:	Understand the construction, operation, performance, starting methods and speed control techniques of Induction Motor.	PO1, PO2
CO3:	Summarize the concepts, characteristics and selection of Electric Drives.	PO1, PO2
CO4:	Describe the different control strategies for Solid State Drives.	PO1, PO2
CO5:	Outline the various speed control techniques for Induction Motor.	PO1, PO2

ELECTRO MAGNETIC INDUCTION & DC MOTORS **9**

Introduction to magnetic circuits - Magnetically induced E.M.F and force - AC operation of magnetic circuits - Hysteresis and Eddy current losses. Energy in magnetic systems - Field energy & mechanical force - Constructional features of DC machine - Principle of operation of DC Machine - EMF and Torque equations.

SINGLE PHASE & THREE PHASE INDUCTION MACHINES **9**

Construction and principle of operation of single phase & three phase induction motors - Torque & Power equations - Slip-Torque characteristics - Starting and speed control of Induction Machines.

ELECTRIC DRIVES **9**

Electric Drives - Advantage of Electric Drives - Selection of motor power rating - Thermal model of motor for heating and cooling - Classes of duty cycle - Determination of motor rating - Control of Electric drives - modes of operation - Speed control and drive classifications - Closed loop control of drives.

SOLID STATE CONTROL OF DC DRIVES **9**

DC motor and their performance - Braking - Transient analysis - Ward Leonard drives - Transformer and Uncontrolled Rectifier Control - Controlled rectifier fed DC drives - Chopper controlled DC drives - Time ratio control and current limit control - Single, two and four quadrant operations - Effect of ripples on the DC motor performance.

SOLID STATE CONTROL OF INDUCTION MOTOR **9**

Induction Motor Drives - Stator control - Stator voltage and frequency control - V/f control - CSI, VSI and cycloconverter fed Induction motor drives - Slip power recovery scheme - Control of rotor resistance using DC chopper.

Total Periods: 45

TEXT BOOKS

1. Bose B.K., "Power Electronics and Variable Frequency Drives", 1st Edition, IEEE Press Standard Publications 2002.
2. Kothari D.P., and Nagrath I.J., "Electrical Machines", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 5th Edition, 2002.

REFERENCES

1. Gupta J.B., "Theory and Performance of Electrical Machines", 14th Edition, S.K.Kataria and Sons, 2009.
2. Dubey G.K., "Fundamentals of Electrical Drives", Narora publications, 1995.
3. Krishnan R., "Electric Motor Drives Modeling, Analysis and Control", 1st Edition, Pearson Publications, 2002.

WEB REFERENCES

1. http://nptel.ac.in/courses/108105017
2. http://nptel.ac.in/courses/108106072
3. https://swayam.gov.in/nd1_noc19_ee65/preview

CASE STUDY

1. Applications of Electrical Machines in Electric Vehicles.
2. Four quadrant operation DC Motor using MATLAB software.
3. Simulation of closed loop control of Induction Motor.
4. Role of Electrical Drives in industries like Textile, Steel, Cement and Paper industries.

20EC2E51 CONSUMER ELECTRONICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the types and working principles of microwave ovens and washing machines.	PO1, PO2, PO3
CO2:	Understand the operations of air conditioners and refrigerators	PO1, PO2, PO3
CO3:	Figure out theengineering concepts used in car computers	PO1, PO2, PO3
CO4:	Comprehend the operations of home/office digital devices	PO1, PO2, PO3
CO5:	Use different product safety, compliance standards and techniques associated with electronic products	PO1, PO2, PO3, PO6

MICROWAVE OVENS AND WASHING MACHINES **12**

Microwave Ovens - Microwaves (Range used in Microwave ovens) - Magnetrons - Microwave oven block diagram -LCD timer with alarm - Single-Chip Controllers - Types of Microwave oven -Wiring and Safety instructions - Washing Machines - Electronic controller for washing machines - Washing machine hardware and software - Types of washing machines - Fuzzy logic washing machines - Features of washing machines.

AIR CONDITIONERS AND REFRIGERATORS **8**

Air Conditioning - Components of air conditioning systems - All-water air conditioning systems - All-air conditioning systems - Unitary and central air conditioning systems - Split air conditioners. Refrigeration - Refrigerants - Refrigeration systems - Domestic refrigerators.

IN-CAR COMPUTERS **8**

Electronic ignition - Lock system - Antilock Braking System (ABS) - Electronically Controlled Suspension (ECS) - Instrument panel displays - Air bag system - Vehicle proximity detection system - Car navigation system.

HOME/OFFICE DIGITAL DEVICES **9**

Digital clocks - Block diagram of a digital clock - Dishwasher - - Set-Top boxes - Digital cable TV - Video on demand. - Facsimile machine - Xerographic copier - Barcode scanner and decoder - Automated Teller Machines (ATMs) - Electronic Fund Transfer.

PRODUCT COMPLIANCE **8**

Product Safety Standards, Electrical Product safety concepts, Testing for Compliance and Safety, EMI/EMC requirements, design techniques for ESD.

Total Hours: 45

TEXT BOOKS

1. Bali, S.P., "Consumer Electronics", Pearson Education, 2008.
2. Anand, M.L, "Consumer Electronics", 3rd Edition, Khanna Publishers, 2006.
3. Steli Loznen, Constantin Bolintineanu & Jan Swart,"Electrical Product Compliance and Safety Engineering", Artech House, 2017

REFERENCE BOOKS

1. B.R. Gupta and V. Singhal, "Consumer Electronics", S.K. Kataria & Sons, 2013.
2. Schuler C.A. and McNamee W.L., "Modern Industrial Electronics", McGraw Hill, 2002.
3. Shanefield, D.J., "Industrial Electronics for Engineers, Chemists and Technicians", 1st Edition, Jaico Publishing House, 2007.

20EC2E52 **MEMS AND NEMS** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Describe the concepts of microsystem technology and materials for MEMS.	PO1
CO2:	Recognize the use of materials in micro fabrication.	PO1
CO3:	Discuss the fabrication processes including surface micromachining, bulk micromachining and LIGA.	PO1
CO4:	Explain the considerations, constraints and process in the design of MEMS devices.	PO1
CO5:	Outline the concepts of nanoelectromechanical systems.	PO1

MEMS AND MICROSYSTEMS **9**

Introduction - MEMS and microsystem products - Microsystems and microelectronics - Applications of microsystems in automotive industry and other industries - Microsensors - Microactuation - MEMS with Microactuators - Microaccelerometers - Microfluidics.

MATERIALS FOR MEMS AND MICROSYSTEMS **6**

Substrates and Wafers - Active substrate materials - Silicon as substrate material - Silicon Compounds - Silicon piezoresistors - Gallium Arsenide - Quartz - Piezoelectric crystals - Polymers - Packaging materials.

MICROFABRICATION AND MICROMANUFACTURING **9**

Photolithography - Ion Implantation - Diffusion - Oxidation - Chemical Vapor Deposition - Physical Vapor Deposition - Etching - Bulk Micromanufacturing - Surface micromachining -LIGA process.

MICROSYSTEM DESIGN **9**

Design considerations - Process design - Mechanical design - Design of silicon die for micropressure sensor - Microsystem Packaging - Essential Packaging Technologies

NANOELECTROMECHANICAL SYSTEMS **12**

Overview: From micro to Nanoscale and Beyond - Sizing features - Design and optimization of nano and Microsystems in the behavioral domain - Biomemitics, Biological Analogies and Design of NEMS - Scaling laws and Mathematical modeling - Nanostuctures - NEMS Architectures - Nanoengineering Bioinformatics and its applications

Total Hours: 45

TEXT BOOKS

1. Tai-Ran-Hsu, "MEMS and Microsystems design and manufacture", 1st Edition, Tata McGraw-Hill, 2017.
2. Sergey Edward Lyshevski, "Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering", 2nd Edition, CRC Press, 2018.

REFERENCE BOOKS

1. John A Pelesko and David H. Bernstein, "Modeling MEMS and NEMS", 1st Edition, CRC Press, 2002.
2. Chang Liu, "Foundation of MEMS", 1st Edition, Peasron Education, 2011.
3. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", 1st Edition, CRC Press, 2018.
4. Stephen D. Senturia, "Microsystem Design", Springer International Edition, 2011.

20EC2E53 IMAGE PROCESSING AND APPLICATIONS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Explain the Fundamentals of image processing	PO1, PO11, PO12
CO2:	Summarize various image Transforms	PO1, PO2, PO5, PO11, PO12
CO3:	Discuss different image enhancement techniques in spatial and frequency domain.	PO1, PO2, PO5, PO11, PO12
CO4:	Describe the concepts of image restoration and segmentation.	PO1, PO2, PO11, PO12
CO5:	Outline the concepts of image Representation and Description.	PO1, PO2, PO11, PO12
CO6:	Explain different image analysis application.	PO1, PO2, PO5, PO11, PO12

BASICS OF IMAGE PROCESSING AND IMAGE TRANSFORM **12**

Introduction - steps in image processing - Image acquisition - representation - sampling and quantization - relationship between pixels - color models - basics of color image processing. Introduction to Fourier transform: 1 - D, 2 - D DFT and its inverse transform - Walsh - Hadamard - Haar transform, DCT.

IMAGE ENHANCEMENT **9**

Image enhancement in spatial domain - some basic gray level transformations - histogram processing - enhancement using arithmetic, logic operations - basics of spatial and frequency filtering: smoothing and sharpening filters.

IMAGE RESTORATION AND SEGMENTATION **9**

Image restoration: Model of degradation and restoration process - noise models - restoration in the presence of noise - Image segmentation: Thresholding and region based segmentation.

IMAGE REPRESENTATION AND DESCRIPTION **9**

Representation and Description: Chain codes-Boundary descriptors -Regional Descriptors - Texture -Morphology - dilation and erosion - opening and closing.

APPLICATIONS **6**

License plate detection, Remote sensing change detection, crack detection, Missing component detection.

Total Periods: 45

TEXT BOOKS

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson Education Limited, 2018.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", 1st Edition, PHI Learning, 2010.

REFERENCES

1. Al.Bovik, "The Essential Guide to Image Processing", Academic Press, 2009.
2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2008.
3. Jayaraman S , Veerakumar T , Esakkirajan S, "Digital Image Processing", 1st Edition, McGraw Hill Education, 2009.

WEB REFERENCE

http://nptel.ac.in/courses/117105079

20EC2E54 **INTERNET OF THINGS** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Explain the basic concepts of IoT and its challenges.	PO1
CO2:	Summarize different communication technologies used for IoT.	PO1
CO3:	Explain the concept of Cloud Computing.	PO1
CO4:	Develop programs for interfacing sensors and communication modules with Arduino microcontroller using Android development platform.	PO1, PO3
CO5:	Explain various IoT applications.	PO1, PO3

INTRODUCTION10

Definition of IoT - Proposed architecture and reference model- Enabling technologies-Application areas: An overview - Challenges

COMPONENTS IN INTERNET OF THINGS **12**

Control Units - Sensors - Basics of Sensors and actuators - Examples and working principles of sensors and actuators - Communication modules - Power Sources - Communication Technologies - RFID - Bluetooth - Zigbee - Wifi - Rflinks - Mobile Internet - Wired Communication.

PROGRAMMING THE MICROCONTROLLER FOR IOT **13**

Introduction to Cloud computing - Arduino Microcontroller platform - Setting up the IDE - Programming for IOT - Reading from Sensors - Connecting microcontroller with mobile devices - communication through blue tooth and USB - connection with the internet using wifi / ethernet

IOT IN CRITICAL APPLICATION DOMAINS **10**

IoT enabled Smart Gas and Water grids - Electric distribution networks - Health care - Automotive Industry

Total Hours: 45

TEXT BOOKS

1. Charalampos Doukas , "Building Internet of Things with the Arduino", Create space, 2012.
2. Qusay F.Hassan, Atta ur Rehman Khan and Sajjid A. Madani, "Internet of things - Challenges, Advances and Applications", CRC Press, 2018.

REFERENCES

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine-to-Machine to the Internet of Things", Academic Press, 2014.
2. Marco Schwartz, "Internet of Things with Arduino Cookbook", Packt Publishing, 2016.

WEB REFERENCES

1. https://www.postscapes.com/
2. https://nptel.ac.in/courses/106/105/106105166/

20EI2E12 PROGRAMMABLE LOGIC CONTROLLER 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Explain the components of Programmable logic controllers.	PO1,PO2
CO2	Summarize the hardware modules in PLC and its functioning.	PO1,PO2
CO3	Develop PLC Ladder logic programs for sequential control applications.	PO1,PO2,PO5
CO4	Establish communication between PLC and PC.	PO1,PO2
CO5	Build a ladder programming for different applications.	PO1,PO2,PO5

PROGRAMMABLE LOGIC CONTROLLER ARCHITECTURE **8**

Evolution of Programmable Logic Controller (PLC) - Advantages over hardwired relay and Microcontrollers - Components in PLC - PLC scan time.

I/O MODULES AND MEMORY **7**

Digital input module - Digital output module - Concept of sourcing and sinking - Analog input module - Analog output module - Local and remote I/O expansion - Special purpose modules Memory organization - I/O addressing - Programming devices.

PROGRAMMABLE LOGIC CONTROLLER SOFTWARE **15**

PLC programming - Basic relay logic instructions - Timers and Counter instructions - Data transfer instructions- Data manipulation instructions - Program control instructions - Simple programs using LD instructions- Functional block diagram programming and sequential chart programming: Simple example programs.

PLC NETWORKING, INSTALLATION AND MAINTENANCE **8**

Types of networking - Connecting PLC with other PLC and PC - PLC installation procedure - PLC selection - Preventive maintenance and trouble shooting of PLCs.

PLC APPLICATIONS **7**

Controlling a Robot and CNC machine using PLC - Packing application using PLC - Traffic light control applications in PLC - Case study on Bottle filling system.

Total Hours: 45

TEXT BOOKS

1. Petruzella F.D, "Programmable Logic Controllers", 5th Edition, McGraw - Hill Publications, 2016.
2. Webb J.W. and Reis R.A., "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall India Pvt. Ltd, 2015.

REFERENCE BOOKS

1. Gray D., "Introduction to Programmable Logic Controller", 3rd Edition, Cengage Learning India Ltd., 2016.
2. Bolton W., "Programmable Logic Controllers", 6th Edition, Elsevier Newnes Publications, 2015.
3. Johnson C.D., "Process Control Instrumentation Technology", 8th Edition, Pearson Education Ltd., 2014.

WEB REFERENCES

1. nptel.ac.in/courses/108105062/18
2. nptel.ac.in/courses/112102011/12
3. https://www.youtube.com/watch?v=UQ16Cous_tY

20EI2E13 AUTOMATION AND MACHINE VISION SYSTEM 3 0 0 3

On successful completion of the course, students will be able to

COURSE OUTCOMES

CO1	Infer the concepts and components of automation.	PO1, PO2
CO2	Identify the controller for automation and programming technique using ladder diagram	PO1, PO2, PO5
CO3	Outline the basic operations of the image processing for vision system.	PO1, PO2
CO4	Interpret the components of imaging system for acquisition and processing.	PO1, PO2
CO4	Illustrate the applications of vision system in the automation.	PO1, PO2

AUTOMATION TECHNOLOGY **10**

Process automation: Necessity and evolution - Basic elements of an automated system - Advanced automation functions - Levels of automation - Continuous versus discrete systems - Hardware components for automation: Sensors, actuator, input/output devices for discrete data.

PROGRAMMABLE LOGIC CONTROLLER **12**

Programmable logic controller: Internal architecture of PLC system - Input and output modules - Programming languages: Ladder logic programming, functional block programming - Ladder diagrams: Logic functions, latching, multiple outputs - Design of ladder diagram: Control the speed of conveyor of bottle filling system, diagnostic program for cylinder action. Case study: Design of mixing of two liquids in a single tank.

IMAGING SYSTEM **15**

Imaging fundamentals: Image acquisition, image sampling and quantization - Image compression: Image compression models, image formats and compression standards - Morphological image processing: Boundary extraction, erosion and dilation, opening and closing - Image segmentation: Line detection, basic edge detection - Region based segmentation: Region growing, region splitting and merging.

Vision Component: Basic component, elements of visual conception, types of lenses - Camera: Sensor, type, size resolution - Computer interface. Case study: Automation on vision based live object monitoring system.

APPLICATIONS OF AUTOMATION AND VISION SYSTEM **08**

Machine learning algorithms and their application in medical image - Motion estimation and object tracking - Face and facial expression recognition - Gesture recognition - Image fusion.

Total Hours:45

TEXT BOOKS

1. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson, 2015.
2. Rafaen C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Illustrated Edition, Pearson Education, 2018.

REFERENCE BOOKS

1. Bolton W., "Programmable Logic Controllers", 4th Edition, Elsevier Newnes, 2006.
2. Petruzella F.D., "Programmable Logic Controllers", 5th Edition, McGraw Hill Publications, 2016.
3. Manas Kamal Bhuyam, "Computer Vision and Image Processing, Fundamentals and Applications", 1st Edition, CRC Press, 2019.

WEB REFERENCES

1. https://www.microscan.com/en-us/blog/solutions-applications/machine-vision-automation microhawk
2. https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs58/

20EI2E14 TESTING AND CALIBRATION OF EQUIPMENTS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Summarize the various uncertainty concepts of measurements.	PO1,PO2
CO2	Infer the various techniques of calibration.	PO1, PO2
CO3	Interpret the procedures of calibration standards.	PO1,PO2
CO4	Outline the functions of calibration techniques.	PO1,PO2
CO5	Illustrate the working of calibration setups.	PO1,PO2

MEASUREMENT UNCERTAINTY **09**

Background-Random and systematic errors-Type A and type B uncertainty-Sensitivity coefficients- Uncertainty evaluation.

CALIBRATION **06**

Objectives - Necessity of calibration - Basic calibration process, various components of a calibration system.

STANDARDS AND STANDARDIZATION **12**

Absolute, primary, secondary, working and census standards, and measurement setup- Interpretation of specifications of various calibration standards and Device Under Calibration (DUCs) - Levels of standard accuracies, accuracy ratio between levels of calibration pyramid - Requirements of traceability - Metrology standardization documents.

CALIBRATION TECHNIQUES **12**

Calibration curve method, Standard additions method, Internal standard method- Comparative technique - Choosing calibration method - Determining calibration intervals- Calibration procedure of voltmeter, multimeter, oscilloscopes, clamp meter, Panel meters.

CALIBRATION SETUPS **06**

Electrical calibration-Temperature calibration-Pressure and flow calibration-Demonstrations- Case study of bio medical instruments calibration- Calibration of instruments using LabVIEW.

Total Hours:45

TEXT BOOKS

1. Mike Cable, "Calibration: A Technicians Guide", ISA Publisher, 1st Edition, 2005.
2. Patranabis D, "Principles of Industrial Instrumentation", Mc-GrawHill Publications, 2nd Edition, 2010.

REFERENCE BOOKS

1. Murty D.V.S, "Transducers and Instrumentation", Prentice-Hall of India Private Limited, 2nd Edition 2009.
2. Mike Cable, "Calibration: A Technicians Guide", ISA Publisher, 1st Edition 2005.
3. Eckman.D.P, "Industrial Instrumentation", Wiley Eastern Ltd, 3rd Edition, 2004.

WEB REFERENCES

1. https://www.youtube.com/watchv=CUmO42_g-es
2. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-10(SS)%20(IA&C)%20((EE)NPTEL)%20.pdf
3. https://nptel.ac.in/courses/112/107/112107242/

20EI2E17 INDUSTRIAL POLLUTION AND CONTROL 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Interpret the types of pollution, their sources and effects	PO1,PO2,PO7,PO12
CO2	Explain the sources and behavior of air pollutants.	PO1,PO2,PO7,PO12
CO3	Outline the various measurement techniques for air pollutants.	PO1,PO2,PO7,PO12
CO4	Infer the different sources, analysis and treatment of water pollution.	PO1,PO2,PO7,PO12
CO5	Identify the hazardous waste with their treatment and disposal methods.	PO1,PO2,PO7,PO12

POLLUTION AND TYPES **05**

Types of pollution - Types of emission from chemical industries and effects of environment - Environment legislation - Effluent guidelines and standards.

AIR POLLUTION **15**

Scales of concentration - Classification and properties of air pollution - Emission sources - Behaviour of Air pollutants: Wet precipitation, chemical reactions in atmosphere, photochemical smog.

Air pollution sampling and measurement - Types - Collection of gaseous air pollutants - Stack sampling - Analysis of air pollutants: Sulphur dioxide, nitrogen oxide, carbon monoxide.

WATER POLLUTION **15**

Origin of waste water - Types of water pollutants: Synthetic organic compounds, sediments, radioactive substances - Methods of analysis: Dissolved oxygen, biochemical oxygen demand, chemical oxygen demand - Waste water treatment: Flotation, aerobic biological treatment - Chemical oxidation.

SOLID WASTE MANAGEMENT: HARZARDOUS WASTE **10**

Sources and classification - Treatment methods: Biological, thermal treatment - Disposal methods: Landfill, underground

Case Studies:

1. Environmental Pollution and Control: A Case Study of Delhi Mega City
2. Assessment of groundwater pollution in North Erode city

Total Hours:45

TEXT BOOKS

1. Rao.C.S, "Environmental Pollution and Control Engineering", 2nd Edition, Wiley Eastern Limited, 2006
2. Swamy A.V.M, "Industrial Pollution Control and Engineering", 1st Edition, Galgotia Publications, 2005.

REFERENCE BOOKS

1. Narayan Rao M., and Datta A.K, "Waste Water Treatment", 2nd Edition, Oxford and IBH Publication, 2005.
2. PrathapMouliP.andVenkataSubbaya N., "Air Pollution Control", 1st Edition, DivyaJyothi Publishers, 2003.
3. Mahanjan S.P, "Pollution Control in Process Industries", 1st Edition, Tata-Mcgraw Hill, 1985.

WEB REFERENCES

1. https://nptel.ac.in/courses/105102089.
2. https://nptel.ac.in/courses/122106030.
3. https://nptel.ac.in/courses/105103205.

20IT2E51 ANDROID APPLICATION DEVELOPMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the key aspects of mobile application development and Android platform.	PO1, PO12
CO2:	Design and develop an Android application using UI resources, intents and threading concepts.	PO2, PO3, PO5, PO12
CO3:	Develop an Android application using services, notifications through broadcast receivers, native data handling techniques, telephony and messaging services.	PO2, PO3, PO5, PO12
CO4:	Apply the concepts of graphics, animation, multimedia, location awareness and sensors to develop mobile apps.	PO2, PO3, PO5, PO12
CO5:	Make use of testing tools like JUnit, Robotium and MonkeyTalk to test the mobile apps.	PO2, PO3, PO5, PO12
CO6:	Build the signed, release-ready APK and distribute mobile apps to market place.	PO2, PO3, PO5, PO12

GETTING STARTED WITH MOBILITY **8**

Mobility Landscape - Mobile Platforms - Mobile Apps Development - Overview of Android Platform -Setting up the Mobile App Development Environment along with an Emulator - A case study on Mobile App Development.

BUILDING BLOCKS OF MOBILE APPS **17**

App User Interface Designing - Mobile UI Resources (Layout, UIelements, Draw-able and Menu) -Activity- States and Life Cycle - Interaction amongst Activities - App Functionality beyond User Interface - Threads - Async Task - Services - States and Lifecycle - Notifications - Broadcast Receivers - Telephony and SMS APIs- Native Data Handling - On-device File I/O - Shared Preferences - SQLite and Enterprise Data Access.

SPRUCING UP AND TESTING MOBILE APPS **15**

Graphics and Animation - Custom Views - Canvas - Animation APIs - Multimedia: Audio/ Video Playback and Record, Location Awareness and Native Hardware Access - Debugging Mobile Apps -Test Automation of Mobile Apps - JUnit for Android - Robotium- Monkey Talk.

TAKING APPS TO MARKET **5**

Versioning - Signing and Packaging Mobile Apps - Distributing Apps on Mobile Market Place.

Total Hours: 45

TEXT BOOK

1. Anubhav Pradhan, Anil V. Deshpande, "Composing Mobile Apps: Learn, Explore, Apply Using Android", 1st Edition Wiley publication, 2014.

REFERENCES

1. Barry Burd, "Android Application Development All in one for Dummies", 1st Edition, John Wiley & Sons Publication, 2011.
2. Charlie Collins, Michael Galpin and Matthias Kappler, "Android in Practice", DreamTech, 2012.
3. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", John Wiley & Sons, Inc.,Wrox, 2012.
4. Lauren Darcey Shane Conder, "Teach Yourself Android Application Development in 24 Hours", 3rd Edition, SAMS Publication, 2013.

20IT2E52 **DATABASE SYSTEMS** **3 0 0 3**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Illustrate the basic concepts and architecture of Database Management System.	PO1, PO2, PO3, PO12
CO2:	Make use of relational algebra, SQL queries to manipulate a database for a given domain.	PO1, PO2, PO3, PO4, PO5, PO12
CO3:	Identify and use suitable normal form for designing relational databases.	PO1, PO2, PO3, PO4, PO12
CO4:	Illustrate storage management and file organization concepts.	PO1, PO2, PO3, PO4, PO12
CO5:	Explain concurrency control and recovery management techniques.	PO1, PO2, PO3, PO4, PO12
CO6:	Summarize various database system architecture, data warehousing & mining and NoSQL databases.	PO2, PO3, PO4, PO5, PO12

INTRODUCTION TO DATABASE AND SQL **18**

Introduction - Introduction to Relational Model - Relational Algebra Operations - Introduction to SQL - Intermediate SQL - Advanced SQL: Functions and Procedures - Triggers.

E-R MODEL, DATABASE DESIGN AND FILE STRUCTURE **12**

Database Design and ER Model - Relational Database Design - Storage and File Structure: Overview of Physical Storage Media, Magnetic Disk and Flash Storage, RAID - File Organization - Organization of Records in Files - Data Dictionary and Storage - Database Buffer.

TRANSACTION MANAGEMENT AND ADVANCED CONCEPTS **15**

Transactions - Concurrency Control - Recovery System -Database System Architecture - Data Warehousing and Mining - Motivation for NoSQL Databases.

Total Hours: 45

TEXT BOOKS

1. Abraham Silberschatz, Henry F Korth and S Sudarshan, "Database System Concepts", 6th Edition, Tata McGraw- Hill, 2010.
2. Dan Sullivan, "NoSQL for Mere Mortals", Addison Wesley, 2015.

REFERENCES

1. Peter Rob, Carlos Coronel, "Database Systems: Design, Implementation and Management", 8th Edition, Thomson Course Technology, 2009.
2. Ramez Elmasri and Shamkant B Navathe, "Fundamental Database Systems", 7th Edition, Addison Wesley, 2016.
3. Raghu Ramakrishnan, "Database Management System", 3rd Edition, Tata McGraw-Hill, 2007.

WEB REFERENCE

1. http://nptel.ac.in/courses/106106093/

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Explore C++ language to implement object oriented concepts.	PO1, PO2, PO3, PO12
CO2:	Acquire knowledge about the concepts of computer architecture.	PO1, PO12
CO3:	Interpret different software development models and UI design.	PO1, PO2, PO12
CO4:	Acquire knowledge about implementing SQL Queries and RDBMS.	PO1, PO2, PO3, PO12
CO5:	Learn about the concepts of operating systems and networking.	PO1

OBJECT ORIENTED PROGRAMMING CONCEPTS USING C++ 12

Introduction to Classes and Objects - Constructors and its types - Destructors - Passing Objects as Function arguments and Returning Objects from Functions - Operator Overloading - Inheritance -Virtual Functions - Friend Functions - Static Functions.

COMPUTER ARCHITECTURE 9

Fundamentals of Computer architecture - Introduction - Organization of a small computer - Central Processing Unit - Execution cycle - Instruction categories - Measure of CPU performance - Memory -Input/output devices - BUS - Addressing modes.

SOFTWARE ENGINEERING 6

System Development Methodologies - Software development Models - UML Class Diagrams - Relationship - User interface Design - Introduction - The process - Elements of UI design & reports.

DATABASE MANAGEMENT SYSTEMS 9

Introduction - Database basics - RDBMS - Database design: Database life cycle - ER modeling - SQL - Need for SQL - Types of SQL - Data types of SQL - Select statement with operators - Single row and Multi row functions - Group by and Having Clauses.

OPERATING SYSTEM AND NETWORKING ESSENTIALS 9

Operating system concepts - Introduction - Functions of Operating System - Types of Operating Systems - Fundamental computer network concepts - Types of computer networks - Network layers - TCP/IP model - Wireless Local Area Network - Ethernet - WiFi - Network components.

Total Hours: 45

TEXT BOOKS

1. Robert Lafore, "Object-Oriented Programming in C++", 4th Edition, SAMS Publishing, 2008.
2. Andrew S. Tanenbaum, "Structured Computer Organization", Pearson, 6th Edition, 2013.
3. Roger S Pressman, "Software Engineering - A Practitioner's Approach", 7th Edition, Tata McGraw-Hill, International Edition, 2015.
4. Ali Bahrami, "Object Oriented Systems Development", 2nd Edition, Tata McGraw-Hill, 2008.
5. Wilbert O. Galitz, "Essential Guide to User Interface Design", 3rd Edition, John Wiley, 2007.
6. James F. Kurose, Computer Networking: A Top-Down Approach, 6th Edition, Pearson, 2012.
7. Silberschatz and Galvin, "Operating System Concepts", John Wiley & Sons, 7th Edition, 2013.
8. Abraham Silberschatz, Henry F Korth and S Sudarshan, "Database System Concepts", 6th Edition, Tata McGrawHill, 2010.

WEB REFERENCES

1. Infosys campus connect portal
2. http://nptel.ac.in/courses/106103068
3. http://nptel.ac.in/courses/106101061/
4. https://nptel.ac.in/courses/106/105/106105151/
5. http://nptel.ac.in/courses/117106113/
6. https://www.scs.stanford.edu/10au-cs144/

20IT2E54 INTRODUCTION TO DATA SCIENCE 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the data science process and its applications.	PO1, PO2,PO12
CO2:	Illustrate the tasks involve in life cycle of Data analytics.	PO1, PO2,PO12
CO3:	Apply the basic data analytics methods for business problems.	PO1, PO2,PO3, PO4, PO5,PO12
CO4:	Apply the advanced analytical methods for business problems.	PO1, PO2,PO3, PO4, PO5,PO12
CO5:	Create effective visualization for the given data.	PO1, PO2,PO3, PO4, PO5,PO12

INTRODUCTION **8**

Big Data and Data Science Hype - Datafication - The Current Landscape - A Data Science Profile, Data Science tools - Applications of Data Science - Introduction to big data Analytics : State of the practice in Analytics - Key roles for the new big data ecosystem - Data Analytics life cycle.

BASIC DATA ANALYTICS METHODS USING R **12**

Introduction to R - Exploratory Data Analysis - Statistical methods for evaluation.

ADVANCED ANALYTICAL THEORY AND METHODS **20**

Clustering - K Means -Association Rules: Apriori, Evaluation of candidate rules - Applications of Association rules, Regression: Linear and Logistic regression - Classification: Decision tree - Naïve Bayes - Time series analysis - ARIMA model -Text Analysis.

DATA VISUALIZATION **5**

Principles - ggplot2 to create custom graph.

Total Hours: 45

TEXT BOOKS

1. "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting", EMC Education Services, John Wiley & Sons, Inc., 2015.
2. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from the Frontline", O'Reilly, 2014.

REFERENCES

1. Joel Grus, "Data Science from Scratch", Copyright © 2015.
2. Roger D. Peng, "R Programming for Data Science", Learn Pub, 2015.
3. Foster Provost and Tom Fawcett, "Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking", ISBN 1449361323. 2013.

WEB REFERENCE

1. https://nptel.ac.in/courses/106/106/106106179/

20ME2E01 INTELLECTUAL PROPERTY RIGHTS FOR ENGINEERS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Classify Intellectual property rights	P05, PO6, PO7, PO8,PO10, PO12
CO2:	Understand Patents and patentability criteria	PO6, PO8, PO10, PO12
CO3:	Demonstrate Patent search in all the aspects	PO6, PO8, PO10, PO12
CO4:	Summarize Industrial Design and IC circuit layout design registration	PO6, PO8, PO10, PO12
CO5:	Illustrate protection of Trade marks	PO6, PO7, PO8, PO10, PO12

INTELLECTUAL PROPERTY RIGHTS AND PATENTS **18**

Introduction, types of intellectual property, international organizations, Agencies and treaties, Importance of Intellectual property rights. India patent revolutions, India patent office procedures.

Introduction to Patents, Patentability criteria, The Patent Act, 1970. Inventions not patentable, Patent Specifications: Provisional and complete - Types of patent applications .Compulsory licensing.

COPY RIGHT LAW **10**

Fundamental of copy right law, Originality of material l, Rights of Reproduction, Rights to perform the work publicly, copy right ownership Issues, Copy Right Registration, Notice of copy right, International copy right law, Copy right infringement.

INDUSTRIAL DESIGNS AND IC CIRCUIT LAYOUT DESIGN **8**

Need for Protection of Industrial, Designs Subject Matter of Protection and Requirements, The Designs Act, 2000, Procedure for obtaining Design Protection, Revocation, Infringement and Remedies.

The Semi Conductor Integrated Circuits Layout Design Act, 2000, Conditions and Procedure for Registration, Duration and Effect of Registration, Assignment and Transmission.

TRADEMARKS AND TRADE SECRETS **9**

Purpose and function of trademarks , Types of Marks, Acquisition of Trade Mark Rights, Categories of Marks, Trade names and business names, Protectable matter , Selecting and Evaluating Trade mark Registration process.

Trade secret law, determination of trade secret status, liability for misappropriations of trade secrets, protection for submission, trade secret litigation.

Total Hours:45

TEXT BOOKS

1. Intellectual property right, Deborah, E. Bouchoux, cengage learning, 4th edition, 2013.

REFERENCES

1. Intellectual property right - Unleasing the knowledge economy, Prabhuddha Ganguli, Tata McGrew Hill Publishing Company Ltd, 2001
2. Ajit Parulekar and Sarita D' Souza, Indian Patents Law - Legal & Business Implications; Macmillan India ltd, 2006
3. B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000
4. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

WEB REFERENCES

1. http://www.ipindia.nic.in/Intellectual Property India.

20ME2E52 ENGINEERING ECONOMICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to;

CO1	Demonstrate the understanding of concept of money and its importance in the evaluation of projects	PO1, PO2
CO2	Discuss the time value of money, and how to sketch the cash flow diagram	PO1, PO2, PO11
CO3	Demonstrate to convert different cash flows into Present worth, Future worth and Annual equivalent worth	PO1, PO2, PO11
CO4	Compare the alternatives using different compound interest factors using the proper Economic analysis tools	PO1, PO2, PO11
CO5	Select a feasible alternative based on the analysis. CO6. Formulate a given problem for decision making	PO1, PO2, PO11

INTRODUCTION TO ECONOMICS **9**

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics - Engineering efficiency, Economic efficiency, Scope of engineering economics - Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio.

VALUE ENGINEERING **9**

Make or buy decision, Value engineering - Function, aims, Value engineering procedure. Interest formulae and their applications -Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

CASH FLOW **9**

Methods of comparison of alternatives - present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

REPLACEMENT AND MAINTENANCE ANALYSIS **9**

Replacement and Maintenance analysis - Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset - capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

DEPRECIATION 9

Depreciation- Introduction, Straight line method of depreciation, declining balance method ofdepreciation-Sum of the year's digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions - procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Total Periods: 45

TEXT BOOKS

1. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.
2. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.

REFERENCES

1. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and Analysis" Engg. Press, Texas, 2010.
2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
3. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012

ENLIGHTENMENT THROUGH EDUCATION
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20ME2E53 ENTREPRENEURSHIP AND FINANCE MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to;

CO1	Outline the concepts of entrepreneurship and characteristics of an entrepreneur	PO1
CO2	Summarize the requirements and components of creativity	PO1
CO3	Describe entrepreneurial motivation concepts and barriers of entrepreneurship	PO1
CO4	Identify start-up opportunities by appraising the characteristics of Small Business Enterprises	PO1, PO2
CO5	Formulate a business plan considering various appraisal methods	PO1, PO5
CO6	Plan required funds from different sources and manage accounts	PO1, PO11

INTRODUCTION TO ENTREPRENEURSHIP **9**

Introduction: Definition & Concept, Five core elements of Entrepreneurship, Entrepreneurship dynamic need. Entrepreneurial values and attitudes, Characteristics and Role demand of entrepreneurship, Principles and essentials of entrepreneurship, Sources of finance for entrepreneurship.

MOTIVATION AND BARRIERS TO ENTREPRENEURSHIP **9**

Creativity, Innovation and idea generation: Creativity and Innovation, Components of creative performance, Creativity, innovation and entrepreneurship, Creative enterprises, The business idea, Project identification and dynamics. Entrepreneurial motivation: Factors for entrepreneurial motivation, internal & external factors. Barriers to entrepreneurship: Environmental, economic and non-economic and personal barriers.

START UPS - OPPORTUNITY IDENTIFICATION AND SELECTION **9**

Small enterprise: meaning and definition, micro and macro units, essentials, features and characteristics, rationale behind micro and small enterprises, role of micro enterprises in economic growth. Business opportunity in various sectors, identification of business opportunity, opportunity selection, steps in setting up of a small business enterprise.

BUSINESS PLAN AND APPRAISAL **9**

Meaning, concept and significance of a business plan, formulation of a business plan, guidelines for formulating a project report, network analysis. Project appraisal: Concepts of project appraisal. Methods of project appraisal: economic, financial, market analysis, environmental clearance for SMEs.

FINANCE MANAGEMENT FOR ENTREPRENEURS **9**

Introduction, financial planning, statement of accounts, balance sheet, operating statement, ratio analysis, fund flow analysis, financial fore casting, working capital management: managing current liabilities, finance for working capital requirement. Introduction to costing, sources of finance.

Total Periods: 45

TEXT BOOKS

1. S.L.Gupta and Arun Mittal, "Entrepreneurship Development", International Book House Pvt.Ltd., 2011.

2. S.S.Khanka, "Entrepreneurial Development", S.Chand and Company Pvt. Ltd., 2013.

REFERENCES

1. Robert D.Hisrich, Mathew J. Manimala, Michael P. Peters and Dean A.Shepherd, "Entrepreneurship" McGraw Hill Education, 2016.
2. Vasant Desai, "The Dynamics of Entrepreneurial Development and Management" Himalaya Publishing House, 2014.

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E54 PROJECT MANAGEMENT 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to;

CO1	Outline the concepts and fundamentals of Project Management.	PO1, PO11
CO2	Describe project selection procedure and practise effective project leader traits.	PO1, PO11
CO3	Plan and schedule a project using various quantitative techniques like PERT, CPM, GANTT Chart etc	PO1, PO5, PO11
CO4	Categorize different resources and manage resources in multi project environment and controls.	PO1, PO5, PO11
CO5	Summarize project audit types and execute Project closure process.	PO1, PO11

INTRODUCTION TO PROJECT MANAGEMENT **9**

Project Management concepts, Importance of Project Management, Types of projects, Project life cycle. Project selection - Feasibility study, Types of feasibility, Steps in feasibility study.

PROJECT SELECTION **9**

Project selection, Portfolio management, Project formulation, Project manager. Planning process tools, Project uncertainty and Risk Management. Project Leadership.

PROJECT PLANNING AND SCHEDULING **9**

Work breakdown structure, Work packages estimate, Project scheduling, PERT & CPM networks, Gantt chart, Lean Project Management and Agile Project Management.

RESOURCE ALLOCATION AND CONTROLLING **9**

Resource utilization, expediting a project resource, Loading and levelling, Managing resources in multi projects environment, Monitoring project performance, Project execution, Project control process, Purpose of project execution and control, Control cycle.

PROJECT CLOSURE **9**

Process of project audit, Post project audit, Normal project closure, Premature closure, Perpetual projects, Project closure process.

Total Periods: 45

TEXTBOOKS

1. Jeffrey K. Pinto, "Project Management - Achieving Competitive Advantage", 5th Edition (Global), Pearson, 2020.
2. Arun Kanda, "Project Management A Life Cycle Approach", Prentice Hall of India, 2011.

REFERENCES

1. Jack Gido, Jim Clements and Rose Baker, "Successful Project Management", Cengage Learning, Edition, 7th Edition, 2017.
2. Prashnna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Tata McGraw Hill, 9th Edition, 2019.

20PH2E01 CHARACTERIZATION OF NANOSTRUCTURES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the principles of Microscopes and Spectroscopes.	PO1
CO2:	Explain the properties of the materials with Optical and Electron microscopes.	PO1
CO3:	Illustrate the characteristics of the materials using Spectroscopic Techniques	PO1, PO5
CO4:	Summarize the properties of the materials with the Resonance and Thermal Methods	PO1

STRUCTURAL CHARACTERIZATION **12**

Structural Characterization - X-ray diffraction - Small angle X-ray Scattering - Optical Microscope - Scanning Electron Microscopy (SEM) - Scanning Probe Microscopy (SPM) - Transmission Electron Microscopy (TEM) and Energy Dispersive X-Ray Analysis (EDAX) analysis - Scanning Tunneling Microscopy (STM) - Atomic force Microscopy (AFM).

SPECTROSCOPIC CHARACTERIZATIONS **13**

Spectroscopic characterizations: Basic concepts of spectroscopy - operational principle and application for analysis of nanomaterials - Ultraviolet-visible (UV-VIS) spectroscopy - Infrared (IR) Spectrophotometery - Principle of operation and application for band gap measurement - Raman spectroscopy

SURFACE CHARACTERIZATION **8**

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy - Low Energy Ion Scattering Spectroscopy (LEISS) - Secondary Ion Mass Spectroscopy (SIMS) - Rutherford Backscattering Spectroscopy (RBS).

RESONANCE METHODS **4**

Resonance Methods Electron Spin Resonance (ESR) - Ferromagnetic Resonance (FMR) - Nuclear Magnetic Resonance (NMR) - Mossbauer Spectroscopy

THERMAL CHARACTERIZATION **8**

Thermal Characterization of Materials: Principle and Applications of Differential thermal analysis (DTA) - Thermogravimetric analysis (TGA) - Differential scanning calorimetry (DSC) - Determination of thermo physical parameters.

Total Hours: 45

TEXT BOOKS

1. B. D. Cullity, "Elements of X -ray Diffraction", Creative Media Partners, LLC, 2017.
2. Ray F. Egerton, "Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM", Springer International Publishing, 2016.

REFERENCES

1. Günter Gauglitz and David S. Moore, "Handbook of Spectroscopy", Wiley VCH Verlag GmbH and Co, 2014.
2. Robert F Speyer, "Thermal Analysis of Materials", New York, Marcel Dekker, Inc., 1994.

WEB REFERENCES:

1. https://nptel.ac.in/courses/118/104/118104008/
2. https://nptel.ac.in/courses/113/106/113106093/
3. https://nptel.ac.in/courses/118/102/118102003/
4. https://nptel.ac.in/courses/118/107/118107015/
5. http://www.digimat.in/nptel/courses/video/113107075/L37.html

20PH2E02 NON-CONVENTIONAL ENERGY RESOURCES 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the new developments in Non-conventional and Renewable energy sources.	PO1
CO2:	Recall the Basics of Solar radiation and application of Solar energy.	PO1, PO5
CO3:	Explain the significance of Wind energy, Biomass energy and Hydrogen energy.	PO1
CO4:	Summarise the principle and applications of Ocean and Tidal energy.	PO1

PREREQUISITE: Nil

CONVENTIONAL AND NON-CONVENTIONAL SOURCES **9**

Introduction to Energy Sources: Energy consumption - World energy futures - Discussion on conventional energy sources - Availability and non-conventional energy sources - Green coal technologies - Petroleum and natural gas - Nuclear fuels - power plants - Hydro sources - power plants - Energy strategies - Energy conservation - Energy audit - Cost of energy.

SOLAR RADIATION AND APPLICATIONS OF SOLAR ENERGY **9**

Solar Radiation: Solar spectra - latitude and longitude - Solar window - Seasonal variations - Daily variation - Hour angle - Calculation of angle of incidence - Angstroms equation - constants - Solar radiation data - Daily global radiation calculations.

Applications of Solar Energy: Solar water heating systems - Solar space heating and cooling systems - active - passive - Solar distillation - Solar cell: fundamentals - characteristics - Construction of module -panel and array - Solar PV systems - Applications.

WIND ENERGY **9**

Nature of wind - Planetary - local day, night winds - Wind power density - Power in wind turbine - Efficiency, torque, thrust calculations - Velocity at different heights - Site selection - Favourable wind speed range - Basic components of wind energy conversion systems - Horizontal - vertical axis wind machines.

BIOMASS AND HYDROGEN ENERGY **9**

Biomass Energy: Principles of bio-conversion - Anaerobic - aerobic digestion - Types of bio-gas digesters - Gas yield - Combustion characteristics of bio-gas - Utilization for cooking - IC engine operation - economic aspects.

Hydrogen Energy: Properties- Production - Electrolysis - Thermochemical method - Hydrogen storage - Utilization of Hydrogen gas.

OCEAN AND TIDAL ENERGY **9**

Ocean Energy: Ocean energy conversion - Energy sources in ocean - Ocean Thermal Energy Conversion (OTEC) - Open - closed cycle - Ocean saline gradient concept - Electrical, non - electrical routes - Bipolar, Mono polar - HVDC cable Transmission - Merits - demerits of ocean energy technologies.

Tidal Energy: Tides - Spring tide, Neap tide - Daily and monthly variations - Tidal range - Tidal power - Types of tidal power plants - Single basin - double basin schemes - Main requirements in tidal power plants - Energy storage - Prospects of tidal power in world.

Total Hours: 45

TEXT BOOKS

1. Rai G.D., "Non-conventional Resources of Energy", Khanna Publishers, 4th Edition, 2010.
2. Khan B.H., "Non-Conventional Energy Resources", McGraw Hill Education, 3rd Edition, 2017.

REFERENCES

1. Rao S., Parulekar, "Energy Technology", Khanna Publishers, 4th Edition, 2005.
2. Pai B.R., Ram Prasad, "Power Generation through Renewable Sources of Energy", Tata McGraw Hill, 1991.
3. Bansal, Kleeman, Meliss, "Renewable Energy Sources and Conversion Techniques", Tata Mc Graw Hill, 1990.
4. Godfrey Boyl, "Renewable Energy: Power Sustainable Future", Oxford University Press, 3rd Edition, 2012.
5. John Twidell, Tony Weir, "Renewable Energy Resources", Taylor and Francis, 3rd Edition, 2015.

WEB REFERENCES:

1. https://en.wikipedia.org/wiki/Renewable_energy
2. https:// nptel.ac.in/courses/108108078/
3. https://nptel.ac.in/courses/121/106/121106014/
4. https://nptel.ac.in/content/storage2/courses/108108078/pdf/chap6/teach_slides06.pdf

ENLIGHTENMENT THROUGH EDUCATION SREC

20PH2E03 SOLAR TECHNOLOGY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the concepts of solar heating, cooling and collecting systems.	PO1
CO2:	Explain the construction and operation of solar thermal Technologies.	PO1
CO3:	Illustrate the principle and working of Thin Film Solar Cells and Photovoltaic systems.	PO1, PO5
CO4:	Summarize the concept of solar passive architectures.	PO1, PO6

SOLAR RADIATION AND COLLECTORS 9

World Energy Requirement - Energy emitted by sun and energy received by earth - Sun - Earth geometry - Solar angles - Angles of incidence - Zenith angle - Azimuthal angle - Hour angle - Latitude and longitude - Solar Spectrum and Solar constant -- Solar Collector Basics - Flat plate collector - Evacuated tubular collectors - Concentrator collectors.

SOLAR THERMAL TECHNOLOGIES 9

Solar heating and cooling system - Principle of working - Types - Design and operation - Thermal Energy storage - Types of thermal Energy Storage systems - Sensible Heat Storage - Liquids - Latent heat Storage -Thermo chemical storage - Solar thermal power plant - Solar Desalination - Solar cooker - Domestic - Community - Solar pond technology - Principle of working and description - Solar drying.

SOLAR PV FUNDAMENTALS 9

Semiconductor - Properties - Energy levels - P-N junction - Homo and hetro junctions -Solar Cell technologies - process in solar cell technologies, Sawing and surface texturing, diffusion process, thin film layers, Metal contact- Crystalline Cells: Mono- crystalline and poly - crystalline cells- Basic Silicon Solar cell - GaAs Solar cells - Dark and illumination characteristics - Efficiency limits -Thin Film Cells - thin film deposition techniques-Advantage of thin film: Copper Indium Gallium Selenide Solar Cell (CIGS) - Tandem - Dye - sensitized - Organic solar cells

SPV SYSTEM DESIGN AND APPLICATIONS 9

Photovoltaic cell - Photovoltaic module - PV array - Solar cell array design concepts - PV system design - Maximum power points tracking - Storage autonomy - Centralized and decentralized SPV systems - Comparative study of Conventional lighting system - solar lighting system- Standalone - Hybrid and Grid connected system - System installation - Operation and maintenances -Electrical safety Rules, Simple First Aid , General safety of tools and equipment - Fundamental of Earthing system - Energy and Role of Photovoltaic - Economics of Solar Photovoltaic systems.

SOLAR PASSIVE ARCHITECTURE 9

Passive heating concepts - Direct heat gain - Indirect heat gain - Thermal storage wall - Attached Green house - Isolated gain and sun spaces - Passive cooling concepts - Evaporative cooling - Shading and ventilation - Radiative cooling - Green coupling - Application of wind - Water and earth for cooling - Paints and cavity walls for cooling - Roof radiation traps - Energy efficient landscape design.

Total Hours: 45

TEXT BOOKS

1. Sukhatme S.P. J K Nayak, "Solar Energy", Tata McGraw Hills Private Company, 4th Edition, 2017.
2. Chetan Singh Solanki, "Solar Photovoltaics, Fundamentals, Technologies and Applications", PHI Learning Pvt Ltd, 2018.

REFERENCES

1. Peter Würfel, Uli Würfel, "Physics of Solar Cells: From Basic Principles to Advanced Concepts", Wiley-VCH, 3rd Edition, 2016.
2. Garg H. P. and Prakash J., "Solar Energy Fundamentals and Applications", Tata McGraw- Hill, 2010.
3. Roger A. Messenger and Jerry Vnetre, "Photovoltaic Systems Engineering", 4th Edition,CRC Press, 2020.
4. Kalogirou S. A., "Solar Energy Engineering: Processes and Systems", Elsevier, 2nd Edition, Academic Press, 2013.
5. Michael Boxwell, "Solar Electricity Handbook", Greenstream Publishing Ltd, UK, 2019.

WEB REFERENCES

1. nptel.ac.in/courses/112105051/
2. www.nptelvideos.in/2012/11/energy-resources-and-technology.html
3. https://nptel.ac.in/courses/112/105/112105050/
4. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ph14

ENLIGHTENMENT THROUGH EDUCATION SREC

20RA2E51 AUTOMATION IN INDUSTRY 4.0 3 0 0 3

COURSE OUTCOMES:

On completion of this course the students will be able to

CO1:	Understand the fundamentals and elements of Automation and Industry 4.0.	PO1, PO6
CO2:	Outline the various technologies for enable the Industry 4.0.	PO1, PO6
CO3:	Identify the concept of Internet of Things in smart systems.	PO1, PO6
CO4:	Summarize the use of robotics and 3D printing in Industry 4.0.	PO1, PO6

INDUSTRY 4.0 **10**

Automation- Principles and Strategies of Automation-basic elements-levels of Automation-smart automation-introduction to Industry 4.0- Reason for Adopting Industry 4.0 - Definition -Main Concepts and Components of Industry 4.0-Technologies of Industry 4.0 - Big Data - Artificial Intelligence (AI) - Industrial Internet of Things - Cyber Security - Cloud - Augmented Reality-Robotics.

TECHNOLOGIES **10**

Technologies for enabling Industry 4.0 - Smart factory - Cyber Physical Systems, Robotic Automation and Collaborative Robots-, Support System for Industry 4.0, Mobile Computing, Digital twin and Cyber Security.

INTERNET OF THINGS **10**

Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Internet of Services- Smart Manufacturing- Smart Devices and Products- Smart Logistics - Smart Cities- Smart home automation - Predictive Analytics -IIoT case studies - Industry 4.0 in healthcare services -Strategies for competing in an Industry 4.0 world

ROBOTICS AND 3D PRINTING FOR INDUSTRY 4.0 **15**

Components of Robots- Sensors in Robotics, Internet of Robotic Things (IoRT)-Human robot interaction-Cloud Robotics and Cognitive Architecture for Cyber Physical Robotics- Autonomous Robots- Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

3D printing technologies - selection of material and equipment- develop a product using 3D printing in Industry 4.0 environment.

Total Hours: 45

TEXT BOOKS

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.
2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

REFERENCES

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
2. J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. "Healthcare 4.0 Next Generation Processes with the Latest Technologies", Palgrave Pivot, 2019.
3. M. P. Groover, Industrial Robotics: Technology, Programming and Applications, 2nd edition, McGraw- Hill, 2012

20RA2E52 SOCIAL ROBOTICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Explain the evolution and design principles in Human Robot Interaction.	PO1,PO6
CO2:	Illustrate the design principles in social robots.	PO1,PO6
CO3:	Categorize the social robots based on the various applications.	PO1,PO6,PO7
CO4:	Explain the ethical implications in robots.	PO1,PO6,PO8

HUMAN ROBOT INTERACTION **11**

Introduction - Robot anatomy - Evolution of Human Robot Interaction (HRI) - Limitation of robotics for HRI - Robot morphology and form - affordances - design patterns - design principles in HRI - Anthropomorphization in HRI Design - Robot appearance and behavior.

SOCIAL ROBOTICS **12**

Design for social robots - Aesthetics - Facial traits - Natural language processing - Spatial interaction for robots: Localization and navigation - Socially appropriate positioning - Spatial dynamics of initiating HRI - Robot motion trajectories - Types of nonverbal interaction.

APPLICATIONS **12**

Service robots - Tour guide robots - Receptionist robots - Robots for sales promotion - Robots for learning - Robots for entertainment - Robots in healthcare and therapy - Robots as personal assistants - Collaborative robots - Self-driving cars - Remotely operated robots - Future applications - Sentient robots - Problems for robot application.

ROBOT ETHICS **10**

Ethical theory for robots - Deontology - consequentialism - Implementing ethics as an architecture - ethical governor - consequence engine - Virtue ethics - Ethics in HRI.

Total Hours: 45

TEXT BOOKS

1. Christoph Bartneck, Tony Belpaeme, Friederike Eyssel, Takayuki Kanda, Merel Keijsers, Selma Sabanovi, "Human-Robot Interaction - An Introduction", Markono Print Media Pte Ltd,2020, ISBN 978-1-108-73540-7
2. Arkapravo Bhaumik, "From AI to Robotics Mobile, Social, and Sentient Robots", CRC Press Taylor & Francis Group,2018, ISBN 978-1-4822-5147-0

REFERENCES

1. Changliu Liu, Te Tang, Hsien-Chung Lin, Masayoshi Tomizuka, "Designing Robot Behavior in Human-Robot Interactions", CRC Press, 2019, ISBN 13 - 9780367179694
2. Patrick Lin, Keith Abney, Ryan Jenkins, "Robot Ethics 2.0: From Autonomous Cars to Artificial Intelligence, Oxford University Press, USA,2017, ISBN 13 -9780190652951.
3. Oliver Korn," Social Robots: Technological, Societal and Ethical Aspects of Human-Robot Interaction", Springer International Publishing,2019, ISBN:978-3-030-17106-3.

20RA2E53 EMBEDDED SYSTEMS FOR ROBOTIC APPLICATIONS 3 0 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1:	Explain the concept of typical embedded systems.	PO1, PO2
CO2:	Describe the firmware of embedded systems and its design.	PO1, PO2
CO3:	Illustrate the various sensor and actuator interfacing using Arduino	PO1, PO2
CO4:	Develop and implement an embedded system necessary to control a typical robot application	PO1, PO2

EMBEDDED SYSTEMS **12**

Embedded systems-General Computing Systems -classification-application- characteristics and Quality Attributes - different microcontroller architectures- ASICs, PLDs, Commercial Off-The-Shelf Components (COTS)-Memory Architectures (RAM/ROM)- Memory selection for Embedded Systems- Sensors and Actuators- Communication Interface: Onboard and External Communication Interfaces.

EMBEDDED FIRMWARE **8**

Reset Circuit- Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

SENSOR AND HARDWARE INTERFACING **10**

Arduino Board-Arduino Family-C language basics- Input and output- Interfacing Arduino with Display Devices-Fire Sensors-Infrared and Ultrasonic Sensor-Temperature Sensor-Dc Motor-Stepper Motor-AC motor with Relay-Real Time Advance Sensors: Color Detect Sensor, Accelerometer Sensor

ROBOTICS AND HARDWARE INTERFACING **15**

Study of Robotic ARM - Configuration- Robot parts and functions-Mobile robots -Localization and Navigation-Real Rime Robots: Line Follower, Stair Climbing Robot, Self-balancing Robot,

Case Studies: Home Automation System- Automated Plant-Watering System - Soccer Playing Robot- Maze Exploration- Automotive Systems-Aerial Robot- Three-Servo Ant Robot - Three-Servo Hexabot.

Total Hours: 45

TEXT BOOKS

1. Shibu K.V, "Introduction to Embedded Systems", Second Edition, McGraw Hill, 2017.
2. Raj Kamal," Embedded Systems- Architecture, Programming and Design", 3rd Edition,2017.
3. Simon Monk, "Programming Arduino, Getting Started with Sketches", McGraw Hill Education TAB, 2012.

REFERENCES

1. Nilanjan Dey, Amartya Mukherjee," Embedded Systems and Robotics with Open-Source Tools", CRC Press, 1st edition, 2016.
2. Rajesh Singh Anita Gehlot), Bhupendra Singh," Arduino-Based Embedded Systems: Interfacing, Simulation, and LabVIEW GUI", CRC Press ,1st edition,2017.
3. Thomas Bräunl, "Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems", Third Edition, Springer-Verlag Berlin Heidelberg, 2008.
4. Groover," Industrial Robotics_ Technology Programming and Applications", 2nd Edition- McGraw Hill Education,2017.

20RA2E54 ROBOTIC SYSTEM ENGINEERING 3 0 0 3

COURSE OUTCOMES:

On completion of this course the students will be able to

CO1:	Outline the fundamentals of robot and basic robot configurations.	PO1,PO2
CO2:	Identify the robot sensors and actuators for industrial applications.	PO1,PO2,PO3
CO3:	Categorize therobots used in various industrial applications.	PO1,PO2,PO12
CO4:	Understand the basics of robot mechanisms and robot programming.	PO1,PO2,PO3,PO9

FUNDAMENDALS OF ROBOT **8**

Need for robots - definition of a robot - Laws of robotics - robot anatomy - robot parts and their functions - types and configurations - co-ordinate systems - specifications - pitch, yaw and roll - degrees of freedom - joint notations - robot motions - work envelope.

ROBOT SENSORS AND DRIVES **12**

Internal and external sensors of robot: Position sensors, Optical Encoders, Proximity sensor, Ultrasonic sensor, Touch Sensor, Tactile Sensors, vision sensors.

Types of Robot drives: electrical, pneumatic and hydraulic drives - Types of Robot End Effectors/grippers: (mechanical, pneumatic, hydraulic, magnetic and vacuum grippers) - Robot/ End - Selection and design considerations of grippers.

ROBOT APPLICATIONS **10**

Material handling, welding, soldering and brazing, painting and coating, machining, machine tending, assembly, inspection, collaborative robots, social and medical robots.

ROBOT KINEMATICS AND PROGRAMMING **15**

Homogeneous transformations (Only basics and simple problems) - Forward and Inverse Kinematics - Methods of Robot programming -Teach Pendant Programming - Open source softwares and tools - Case Studies: Simulation of simple pick and place programs using Robotstudio software, Robot programming and palletizing operations using teach pendant.

Total Hours: 45

TEXT BOOKS

1. Groover M.P., "Industrial Robotics - Technology, Programming and Applications", Tata Mcgraw Hill Education, 2nd Edition (Special Indian Edition), 2012.
2. Saha, "Introduction to Robotics", Tata McGraw-Hill Education, 2nd Edition, 2008.

REFERENCES

1. Deb S.R.,"Robotics Technology", Tata McGraw-Hill Education, 2nd Edition, 2010.
2. Fu K.S.,Gonzalz R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill,1st Edition, 2008.
3. Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning, 2009.
4. John.J.Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education India, 3rd Edition, 2008.
5. YoramKoren., "Robotics for Engineers", McGraw-Hill Book Co., 12th Edition, 2007

20NT2E01 FUNDAMENTALS AND APPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY 3 0 0 3

COURSE OUTCOMES

On completion of this course the students will be able to

CO1:	Understand the various methods of preparation of Nanomaterials	PO1, PO2
CO2:	Comprehend the properties and functions of nanomaterials used in different industries / domains	PO1, PO2
CO3:	Acquire knowledge on nanotechnology based alternate energy and healthcare applications	PO1, PO4

BASICS AND SCALE OF NANOTECHNOLOGY **9**

Introduction - Time and length scale in structures - Definition of a Nanosystem - Dimensionality and size dependent phenomena - Surface phenomenon - surface to volume ratio, fraction of surface atoms, surface energy and surface stress, surface defects - Scientific revolutions - Potential applications involving Nanotechnology - Scope of Nanoscience and Technology.

STRUCTURAL NANOMATERIALS **9**

High strength materials - Carbon nanostructures - Heat exchangers and coolants - Biofouling and Corrosion prevention - Water repellent and insulating paints - Foldable light weight solar cells - Regulation of building environment using nanosensors - Super Hydrophobic Coating - Waste water treatment by photocatalysis - Super insulators : aerogels -Nanosorbents.

NANOELECTRONICS **9**

Nano ferroelectrics - Ferroelectric random access memory -Fe-RAM circuit design - Solar energy conversion - Molecular and printed electronics - Nanoelectronics - Applications in displays and other devices - Nano Robots - Nanomaterials for data storage - NanoBiosensors - Electronic noses - Identification of hazardous solvents and gases - Semiconductor sensor array.

FUNCTIONAL-HYBRID NANO MATERIALS **9**

Nanomaterials for corrosion prevention - Hydrogen fuel: storage and harvesting - Emission control - Nano lubricants - Nanoengines - Nanofluidics - Space applications - Smart and functional fabrics - Fire retardant and insulating materials- Electrochromic glasses - Self healing materials - Shape memory alloys.

NANO BIOMATERIALS **9**

Bionics- Swim-suits with shark-skin-effect, Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes) - Modern textiles (Lightweight bulletproof vests and shirts, Color changing property, Smart Fabrics - Cosmetics -Sun-screen dispersions for UV protection using Titanium oxide - Color cosmetics - Nano Drug Delivery systems - Nano Tissue engineering scaffolds.

Total Hours: 45

TEXT BOOKS:

1. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002.

3. Mick Wilson, Kamali Kannargare., Geoff Smith, "Nano technology: Basic Science and Emerging technologies", Overseas Press, 2005.

4. Biomedical applications of nanotechnology edited by Vinod Labhasetwar and DiandraL.Lesie - Pelecky.

REFERENCES:

1. Mark A. Ratner, Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Prentice Hall P7R:1st Edition, 2002.

2. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, "Nanoscale Science and Technology", John Wiley & Sons, Ltd., UK, 2005.

3. Mancini L H, Esposito C L., "Nanocomposites: Preparation, Properties and Performance" Nova Science Publisher Inc., 2008

4. A. Nouailhat, "An Introduction to Nanoscience and Nanotechnology", John Wiley & Sons, Inc., UK, 2008.

5. Bandhyopadyay A K., "Nanomaterials" New Age International (P) Ltd., Publishers., 2008

VIDEO LECTURES

1. Nanostructured Materials-Synthesis, Properties, Self Assembly and Applications, http://nptel.ac.in/courses/118102003/, IITD 2014

2. Soft Nanotechnology, https://www.class-central.com/course/nptel-soft-nano-technology-9923, IITKG 2018

WEB REFERENCES

1. http://www.scielo.br/scielo.phpscript=sci_arttext&pid=S0101-20612010000300002

2. http://journal.frontiersin.org/article/10.3389/fphys.2014.00002/full

CASE STUDIES

1. Case studies on textile industry effluent treatment

2. Case studies on ultra-low dimension computing processors

20NT2E02 NANOTECHNOLOGY IN ENVIRONMENTAL REMEDIATION 3 0 0 3

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1:	Understand and explain the various methods of environmental augmentation strategies using nanomaterials	PO1,PO3,PO7
CO2:	Design various detection and remedial measures for large scale agricultural and industrial bodies using nanoparticles	PO1,PO3,PO7
CO3:	Identify and manage the exposure of various nanoparticles used for environmental remediation activities	PO1,PO3,PO7

INTRODUCTION TO NANOTECHNOLOGY **9**

Importance of Nanotechnology - Opportunity at the nano scale - Length and time scale in structures - Energy landscapes - Interdynamic aspects of inter molecular forces - Classification based on the dimensionality - Nanoparticles - Nanoclusters - Nanotubes - Nanowires and nanodots - Semiconductor nanocrystals carbon nanotubes - Influence of Nano structuring on Mechanical, optical, electronic, magnetic and chemical properties

PHYSICAL PROCESSES FOR AUGMENTATION OF GREENER ENVIRONMENT **9**

Current scenario and conventional strategies - Necessity for water treatment measures - Adsorption - Agricultural wastage treatment - Nanofertilizers and Nanobiochar - Nanopesticides and pesticides degradation

CHEMICAL PROCESSES FOR ENVIRONMENTAL REMEDIATION **9**

Current scenario and conventional strategies - Photocatalytic oxidation of waste from water using semiconductor nanoparticles - Industrial treatment processes by Nanomaterials - Soil enrichment by augmenting microbiome growth

LARGE SCALE ENVIRONMENTAL TREATMENT PROCESSES **10**

Current scenario and conventional strategies -Anaerobic method - Aerobic method - Detection and removal of contaminants in large water bodies by nanobiosensors - Electrobioremediation - Nanoremediation - Nanomembranes for filtration of pathogens and potable water generation - Nanobiocomposites for water purification - Anti microbial nanoparticles for air purification in solid landfills

FATE OF NANOPARTICLES **8**

Current scenario and future directions - Effect of non degradable nanoparticles in the environment - Necessity for recycling and reusing of nanoparticles used in large scale - Monitoring and removal strategies for air and water suspended nanoparticles

Total Hours: 45

TEXT BOOKS

1. Rao C.N.R, Muller.A and Cheetham A.K, "The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Volume-I and II", John Wiley & Sons Inc, 2005.
2. Grassian V.H, "Nanoscience and Nanotechnology - Environmental and health impacts", John Wiley & Sons, 2008.

REFERENCE BOOKS

1. Awan T.I, Bashir A, Tehseen A, "Chemistry of Nanomaterials - Fundamentals and Applications", Elsevier, 2020.
2. Ram M, Andreescu.S.E, Hanming.D, "Nanotechnology for Environmental Decontamination", McGraw Hill, 2007.
3. Hussain C.M and Mishra A.K, "Nanotechnology in Environmental Science", Wiley, 2018.
4. Fulekar M.H and Bhawana P. "Environmental Nanotechnology" CRC Press, 2018.
5. Gothandam K.M, Ranjan S, "Nanotechnology, Food Security and Water Treatment", Springer. 2018.
6. Lofrano G, Libralato G and Brown J, "Nanotechnologies for Environmental Remediation", Springer, 2017.
7. Islam S U, "Environmental Nanotechnology for Water Purification", Wiley, 2020.

N PTEL MATERIAL

1. Nanostructures and Nanomaterials: Characterization and Properties, Dr.Anandh Subramaniam, IIT Kanpur, https://nptel.ac.in/courses/118/104/118104008/
2. Nanotechnology in ground improvement and site remediation, Dr.G.L.Sivakumar Babu, IIsc Bangalore. https://nptel.ac.in/content/storage2/courses/105108075/module9/Lecture40.pdf

WEB RESOURCES

1. Thin films for Wastewater Treatment, by School of Mechanical Engineering at Georgia Tech, https://www.youtube.com/watch?v=GtxB2vMVaHI

20MA2E01 MATHEMATICS FOR DATA SCIENCE 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the student will be able to

CO1:	Infer various aspects data analytics problems using large and small sample tests.	PO1, PO2, PO5, PO9
CO2:	Use ANOVAto find the statistical differences between three or more independent groups.	PO1, PO2, PO5, PO9
CO3:	Demonstrate predictive analytics techniques and build Mathematical Models for the given data.	PO1, PO2, PO5, PO9
CO4:	Use matrix decomposition algorithms in finding the solutions of Data Science problems.	PO1, PO2, PO5, PO9

TESTING OF HYPOTHESIS **15**

Large sample tests: Test of significance for single proportion, difference of proportions, Single mean and difference of means - Small sample tests: t- test for single mean and difference of means, F- test for variances - Chi square test for goodness of fit and independence of attributes - ANOVA table for one way and two way classification.

CORRELATION AND REGRESSION ANALYSIS **15**

Correlation and causation, Types of correlation, Karl Pearson's coefficient of correlation - Regression lines - linear regression equations - coefficient of determination - Analysis of residuals - Estimation and prediction of regression equations - Multiple linear regression model - Logistic Regression.

LINEAR ALGEBRA **15**

Vectors - basic operations on vectors -Dependence and independence of vectors -Matrix Decomposition Algorithms: Special Matrices and their Properties - Spectral decomposition - Singular Value Decomposition (SVD) - Properties- LU Decomposition - Gram Schmidt Process - QR Factorization - Polar Decomposition

Total Periods: 45

TEXT BOOKS

1. Neil A. Weiss, "Introductory Statistics", Pearson Education, 10th Edition, 2017.

2. Alan Jeffrey, "Matrix Operations for Engineers and Scientists: An Essential Guide in Linear Algebra, Springer, 2010.

REFERENCE BOOKS

1. Jay L. Devore," Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9thEdition, 2016.

2. Stephen Andrilli and David Hecker, "Elementary Linear Algebra", 5th Edition, Academic Press, 2016.

WEB REFERENCES

https://nptel.ac.in/courses/110/106/110106072/

https://nptel.ac.in/courses/106/107/106107220/

20MA2E02 MATHEMATICS FOR MACHINE LEARNING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the student will be able to

CO1:	Apply principles of matrix algebra to Linear Transformations.	PO1, PO2, PO5, PO9
CO2:	Demonstrate matrix decomposition techniques in finding solutions of Machine Learning problems.	PO1, PO2, PO5, PO9
CO3:	Use gradient based methods in finding the optimum value of multivariable functions.	PO1, PO2, PO5, PO9
CO4:	Solve nonlinear optimization problems using Search Methods.	PO1, PO2, PO5, PO9

LINEAR ALGEBRA **20**

Vector Spaces and Subspaces - Basis and Dimensions - Linear Transformation - Eigen Values and Eigen Vectors - Matrix Decomposition Algorithms: Special Matrices and their Properties - Spectral decomposition - Singular Value Decomposition (SVD) - Properties- LU Decomposition - Gram Schmidt Process - QR Factorization - Polar Decomposition

MULTIVARIABLE CALCULUS **8**

Partial derivatives - Gradient - Directional Derivatives - Jacobian - Hessian Matrix - Convex functions and its properties.

MULTIVARIABLE OPTIMIZATION **17**

Unconstrained Multivariable Optimization - Unidirectional Search - Direct Search Methods - Box's Evolutionary Optimization Method - Hooke - Jeeves Pattern Search Method - Gradient-based Methods - Cauchy's (Steepest Descent) Method - Marquardt's Method - Conjugate Gradient Method - Solution of Unconstrained Non-Linear Programming Problem by using One Dimensional Search Procedure and the Gradient Search Procedure.

Total Periods:45

TEXT BOOKS

1. Gilbert Strang, "Introduction to Linear Algebra", 5th Edition, Wellesley Cambridge Press, 2016.

2. Kalyanmoy Deb, "Optimization for Engineering: Design-Algorithms and Examples", PHI second edition, 2013.

REFERENCE BOOKS

1. S. Axler, Linear Algebra Done Right (Third Edition). Springer International Publishing, 2015.

2. S.S.Rao, "Engineering Optimization-Theory and Practice", John Wiley and sons Inc., Fifth edition, 2019.

3. RanjanGanguli, Engineering Optimization - A modern approach, Universities Press, First Edition, 2012.

WEB REFERENCES

https://nptel.ac.in/courses/111/107/111107137/

https://nptel.ac.in/courses/106/108/106108056/

20MA2E03 OPERATIONS RESEARCH 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Formulate and solve real life situations involving linear variables.	PO1, PO2, PO5, PO9
CO2:	Optimize transportation and assignment problems.	PO1, PO2, PO5, PO9
CO3:	Find optimal replacement period.	PO1, PO2, PO5, PO9
CO4:	Analyze Network Models.	PO1, PO2, PO5, PO9

LINEAR PROGRAMMING **10**

Formulation of Linear Programming models - Graphical solution - Simplex method -Artificial Variable Techniques- Big-M method - Duality- Primal-dual relationship.

TRANSPORTATION AND ASSIGNMENT PROBLEMS **15**

Transportation Problem - Balanced transportation problem - Unbalanced transportation problem - Initial Basic feasible solution by Vogel's Approximation Method - Optimal solution by MODI method - Assignment problem - Balanced assignment problem - Unbalanced assignment problem - Hungarian method - Travelling Salesman Problem.

REPLACEMENT MODELS **10**

Replacement of items that deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fails suddenly: individual replacement policy, group replacement policy.

NETWORK SCHEDULING **10**

Network and basic components - Rules of network construction - Time calculations in networks - Critical path method -Project Evaluation and Review Technique - PERT calculations.

Total Periods: 45

TEXT BOOKS

1. Taha H.A., "Operation Research", 10th Edition, Prentice Hall of India,2018.

2. KantiSwarup, GuptaP.K. and Man mohan, "Operations Research", Sultan Chand & sons, 2010.

REFERENCES

1. Fredrick S. Hillier and Gerald J. Liebermann, "Introduction to Operations Research", 11thEdition, McGrawHill, 2021.

2. Anderson, "Quantitative Methods for Business", 12th Edition, Thomson Learning, 2013.

3. Sharma J.K., "Operations Research Theory and Applications", 3rd Edition, MacMillan Business Books, 2006.

WEB REFERENCE

https://online courses.nptel.ac.in/noc17_mg10

20MA2E04 STATISTICS FOR BIG DATA ANALYTICS 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the students will able to

CO1:	Understand the foundations of big data and Essentials of Statistics.	PO1, PO2, PO5, PO9
CO2:	Use the advanced Statistical methods in solving the problems of big data analytics.	PO1, PO2, PO5, PO9
CO3:	Analyse the data using Testing of Hypothesis.	PO1, PO2, PO5, PO9
CO4:	Analyse the variance using ANOVA	PO1, PO2, PO5, PO9

DATA SCIENCE AND BIG DATA ANALYTICS **10**

Classification of Digital Data, Structured and Unstructured Data - Introduction to Big Data: Characteristics - Evolution - Applications of Data - Data Warehouse and Hadoop Environment. Big Data Analytics: Classification of Analytics - Challenges - Data Science Terminologies used in Big Data Environments - Soft State Eventual Consistency - Top Analytics Tools.

STATISTICAL ANALYTICS **17**

Introduction to Machine Learning, Data Mining, Text Mining. Naïve Bayesian classifier, decision tree classifier - categorization using K - means clustering and association rules - predictive modelling using Linear, Multiple and logistics regression.

HYPOTHESIS TESTING **18**

Sampling Techniques- Estimation- Parametric Test- Z Test-Single Mean and difference of means-t test-F Test-Chi Square test- Non-Parametric Test- Kruskal Wallis Test-Mann Whitney U Test. Design of Experiments, ANOVA - One Way and Two-Way classification.

Total Periods: 45

TEXT BOOKS

1. Seema Acharya, SubhashiniChellappan, "Big Data and Analytics", Wiley Publications, Fourth Edition, 2020
2. Sheldon M. Ross, "Probability and Statistics for Engineers and Scientists", Elsevier India Private Ltd, 6th Edition, 2020.

REFERENCE BOOKS

1. Neil A. Weiss, "Introductory Statistics", Pearson Education, 10th Edition, 2017.
2. Ronald E. Walpole, Raymond H. Myers and Sharon L. Myers, "Probability & Statistics for Engineers and Scientists", Prentice Hall of India Private Ltd 9th Edition,2017.
3. Morris H DeGroot, Mark J Schervish, "Probability and Statics", Addison Wesly, 4th Edition, 2015.
4. Michael Berthold, David J. Hand Intelligent Data AnalysisSpringer2007

WEB REFERENCES

1. https://www.coursera.org/lecture/big-data-language-1/1-1-introduction-to-big-data-and-language-6tLnz
2. https://www.coursera.org/learn/big-data-introduction
3. https://nptel.ac.in/courses/106/104/106104189/
4. https://nptel.ac.in/courses/106/106/106106142/

20MA2E05 GRAPH THEORY AND ITS APPLICATIONS 2 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the basic concepts of graph theory and c ompute the distance in graphs and weighted graph.	PO1, PO2, PO5, PO9
CO2:	Use the fundamental theorems in Graph theory to study matching, connectivity, coloring and planar graphs.	PO1, PO2, PO5, PO9
CO3:	Analyze matching problems.	PO1, PO2, PO5, PO9
CO4:	Apply graph model and algorithm for solving network problems.	PO1, PO2, PO5, PO9

FUNDAMENTALS OF GRAPHS AND TREES **15**

Graphs - Introduction - Isomorphism - Sub graphs - Walks - Paths - Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits. Trees - Distance and centers in tree - Rooted and binary trees - Spanning trees - Spanning trees in a weighted graph.

PLANAR, DUAL GRAPHS AND MATRIX REPRESENTATION OF GRAPHS **15**

Planar and dual graphs - Combinatorial representation- Detection of planarity - Geometric dual graphs. Incidence matrix - Sub matrices - Circuit matrix - Path matrix - Adjacency matrix. Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Vertex coloring - Edge coloring - Four color problem.

DIRECTED GRAPHS, GRAPH THEORETIC ALGORITHMS **15**

Digraphs - Types of digraphs - Directed paths and connectedness - Euler graphs - Adjacency matrix of a digraph. Algorithms - Connectedness and components - Spanning tree - Fundamental circuits - Cut vertices - Directed circuits - Shortest path algorithm.

Total Periods: 45

TEXT BOOKS

1. NarasingDeo, "Graph theory with application to Engineering and Computer Science", Prentice Hall India, 2016.
2. West D.B, "Introduction to Graph Theory", 2nd Edition, Prentice Hall, 2016.

REFERENCES

1. Harary F., "Graph Theory", Addison Wesley, 2019.
2. Wilson R.J., "Introduction to Graph Theory", 5th Edition, Pearson Education, 2010.

WEB REFERENCE

https://onlinecourses.nptel.ac.in/noc20_ma05/course

20EN2E01 LIFESKILLS & PERSONALITY DEVELOPMENT 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, student will be able to

CO1	Realize the need for good social and professional behavior.	PO9, PO10, PO12
CO2	Introspect and soul-search to set realistic and concrete goals.	PO9, PO10, PO12
CO3	Accept heterogeneity and dynamism in social circles	PO9, PO10, PO12
CO4	Recognize that personal branding can lead to better chances of achieving personal andprofessional goals.	PO9, PO10, PO12

SOCIAL CONDUCT **10**

Etiquette: As a code of conduct - Origins & Types - Online Communication. Emotional Intelligence: What is Emotional Intelligence - Enhancing your emotional self-awareness - Impact of emotional intelligence - Strategies to hone emotional intelligence - crisis management and emotional intelligence.

ATTRIBUTES IN PERSONAL DEVELOPMENT **10**

Goal Setting: Creating purpose and finding goals - smart goals - goal setting in workplace - evolution and incorporation of goals - strategies in setting goals - the power of positive thinking - building positive attitude - strategies of positive attitude - causes of negative attitude.

DEALING WITH PEOPLE **15**

Interpersonal Skills: Definition & Types of Interpersonal Skills, Acquiring and developing Interpersonal skills. Conflict Management: Value of Conflict Management skills. Stress Management: Symptoms of stress, Effective ways to identify stress, Techniques & strategies in managing stress.

IMPRESSION MANAGEMENT **10**

Transition from education to employment - preparing for employment - Image management: building a self-image - image creation and growth - branding in the digital world - Interview Skills: Purpose and types of interview - interview techniques and questions - use of body language and stories. Public Speaking: effective public speaking - language and skills for effective speaking

Total hours: 45

TEXT BOOK

Shinde Maithry, et all, Life Skills and Personality Development, Cambridge University Press, New Delhi, 2022.

REFERENCE BOOKS

1. Pillai Sabina &Agna Fernandez, Soft Skills & Employability Skills, Cambridge University Press, 2022.
2. Hurlock, E.B (2006).Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.
3. Andrews, Sudhir.How to succeed at Interviews.21st (rep) New Delhi. Tata McGraw-Hill.1988.
4. Lucas, Stephen. Art of Public Speaking. New Delhi.Tata-Mc-Graw Hill.2001.

20EN2E02 ART OF SPEAKING 1 2 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO 1	Realize and execute the significance of speaking.	PO9, PO10, PO12
CO 2	Understand the fundamentals of speaking such as vocabulary, pronunciation and basic conversation skills	PO9, PO10, PO12
CO3	Gain proficiency in speaking.	PO9, PO10, PO12

INTRODUCTION TO THE ART OF SPEAKING **15**

Verbal and Non-Verbal Communication - Effective Communication- Stages of communication -Types of communication- Active Listening - Communication Flow- The seven Cs of communication - Barriers of communication - Dealing with feelings in communication

PHONETICS **15**

Phonemes of English: Vowels - diphthongs and consonants - Stress and rhythm - Intonation - Voice and delivery: pace, pause, pitch, volume, modulation and resonance - tips to improve voice, delivery- Practicing vowels, consonants and diphthongs in words and sentences.

FORMAL AND INFORMAL SPEAKING **15**

Basic conversational skills: Self Introduction- greetings- seeking information, permission, accepting and declining. Professional speaking skills: Attributes of presentation and Group discussion - How to make a successful spoken presentation - participating in Group Discussion, appearing in an interview, participating effectively in business meetings.

Total Hours: 45

TEXT BOOK

Stephen E Lucas, The art of Speaking. MC Graw Hill.2020

REFERENCE BOOKS

1. Dr.T.Balasubramainam," The text book of English Phonetics for Indian Students" Macmillan,2020.
2. Kenneth Anderson,Joan Maclean and Tony Lynch. "Study Speaking: A Course in Spoken English for Academic Purpose." Cambridge University Press India Pvt.Ltd. 2004.
3. Owen Hargie, "The Handbook of Communication Skills." Routledge Taylor & Francis Group, New York, 2019.

WEB REFERENCES:

1. NPTEL 8 WEEKS COURSE:https://onlinecourses.nptel.ac.in//noc22_hs13

20EN2E03 GENERIC SKILLS FOR EMPLOYABILITY 2 1 0 3

COURSE OUTCOMES

On completion of the course, the students will be able to

CO 1	To improve knowledge, skills, and habits on how to use digital devices more efficiently for both business and personal reasons.	PO9, PO10, PO12
CO 2	Introspect and develop a planned approach towards one's career and life in general.	PO9, PO10, PO12
CO3	To comprehend career planning process and to be able to match one's skills and interests to the desired career path.	PO9, PO10, PO12

DIGITAL LITERACY **9**

Role of digital technology in day-to-day life and in a workplace- Types of digital devices-Mobile phones-Computers - parts, functionality and usage- Managing files and folders-Microsoft and its applications - MS Word, MS Excel, MS PowerPoint, MS Outlook- The Internet - connecting, accessing information- Accessing information on Government portals and online utility portals- Importance of email- Social media platforms and basic features.

FINANCIAL LITERACY **9**

The importance and benefits of saving money- Methods of saving money- Types and features of bank accounts-Microfinance- Microfinance Institutions (MFIs)- Post office schemes- Using a bank account- Electronic funds transfer and digital/online transactions- Linking bank account with mobile number- Banking cards and their features- Loans and their types- Insurance -Investment options -Taxation- Security.

PERSONAL DEVELOPMENT **9**

Effective communication- Written communication (formal and informal) - Barriers to communication - Etiquette (verbal and nonverbal) - Legal implication of social media communication- Personal qualities, interests and personality traits- Values and the value system- Personal branding for success- Self-esteem- Personal and professional hygiene- Goals setting and obstacles- Dealing with stress and anger- Time management-Positive thinking- Good work ethics- Security regulations at the workplace.

PEOPLE CONNECT **9**

Ways of working with others- Diversity at workplace- Identifying organisational norms and adapting to them-Demonstrating self-worth and a positive attitude at the workplace- Flexibility and adaptability to change- Taking initiative at the workplace-Team skills- Effective use of human resources-Grooming for the workplace- Types of customers- Customer needs and expectations-Customer handling skills- -Customer satisfaction and retention-Resolution of customer issues.

EMPLOYMENT **9**

Preparing a résumé - Online job search services- Preparing for and facing an interview- Group Discussion (GD) - Importance of current information related to the sector/market- Researching the job market / job roles- Awareness of compensation standards- new developments in the fields of education and technology- The need for up-skilling/reskilling.

Total Hours: 45

TEXT BOOK

Agna Fernandez, Generic Skills for Employability, Cambridge University Press India Pvt. Ltd, 2020.

REFERENCE BOOKS

1. Cooper Nicola, Forrest Christy, Cramp Paul, Essential Guide to Generic Skills, Blackwell Publishing, 2006
2. NawaleArvind, M MNivargi, GahelotManisha, An Introduction to Employability Skills, Macmillan, 2018
3. Khabeishvili Guranda, Promoting Generic Employability Skills Development in Higher Education, LAP Lambert Academic Publishing, 2019.

20EN2E04 **GENDER PERSPECTIVE IN TEAM BUILDING & LEADERSHIP** **3 0 0 3**

COURSE OUTCOMES:

On the successful completion of the course, the student will be able to:

CO1	Develop knowledge on various leadership scales	PO9, PO10, PO12
CO2	Apply techniques for developing inter-personal communication skills and positive attitude leading to their professional competence.	PO9, PO10, PO12
CO3	Gain knowledge on team building skill with gender perspective.	PO9, PO10, PO12
CO4	Acquire the various life skills needed to excel in the professional world	PO9, PO10, PO12

MODULE I: LEADERSHIP & GENDER **10**

Leadership Basics-Theories - Importance of Leadership-Role of a Leader- Leadership and Management- Leader versus Manager- Authority vs Leadership- Leadership and Motivation- Emotional Intelligence for Leaders- Organizational Leadership- Myths about Leadership- Assessing Leadership & Measuring its Effects -Women and Leadership- Leadership Ethics-Listening and Communicative skills

MODULE II: FOCUS ON THE LEADER IN GENDER PERSPECTIVE **13**

Leadership Strategy-Leadership Styles-Personal Leadership Brand- Leadership Levels- Leadership and Subordinate Development- Intrinsic vs Extrinsic Motivation-Leadership for the 21st Century- Traits of Effective Leadership- Compassion in Leadership- social media Skills for Leaders- Leadership and Trust- Leadership Behaviour and gender inclusive leadership -Role of Leader in case of Emergency -Inter personal relations -Analysis of Life Positions with gender lens- Case Studies.

MODULE III: ROLE OF GENDER INCLUSIVE TEAM **13**

Team work & Team building -Aspects of Team building-Skills needed for Teambuilding-Team versus Group-Role of a Team Leader-Interpersonal skills - Conversation, Feedback, Feed forward -Delegation, Trust, Expectations, Values, Status, Compatibility -Loopholes in team work -success of team work and gender influence- Team building activities -Communication activities- Problem solving and decision-making activities-Trust-building activities.

MODULE IV: GENDER PERSPECTIVE IN CONFLICT MANAGEMENT **9**

Introduction -Types-Cognitive Conflict & Emotional Conflict -Levels of conflict -Intrapersonal & Interpersonal Conflict -Intra & Inter-group Conflict -Intra-Organizational Conflict- Conflict Resolution Style with gender notion- Self-Discipline- Build Self Confidence and Self Esteem -SWOT Analysis

TEXT BOOK

Adair, John. Effective Leadership (new Revised Edition): How to Be a Successful Leader, 2011. Print.

REFERENCE BOOKS

1. Achua, Christopher F, and Robert N. Lussier. Effective Leadership. Mason, Ohio: South-Western, 2010. Print.
2. Gary, N P. Gender and Leadership. SAGE Publications Ltd, n.d. Internet resource
3. Ellet, William. The Case Study Handbook: How to Read, Discuss, and Write Persuasively About Cases; [5 Sample Cases Included]. Boston, Mass: Harvard Business School Press, 2009. Print.
4. Alex, K. Soft Skills: Know Yourself & Know the World. New Delhi: S. Chand & Company Ltd, 2012. Print.

RELATED ONLINE CONTENTS

1. https://en.wikipedia.org/wiki/Sex_differences_in_leadership
2. https://www.managementstudyguide.com/leader_versus_manager.htm
3. https://www.verywellmind.com/how-to-write-a-psychology-case-study-2795722
4. NPTEL Video:https://youtu.be/0TttNypNWNM
5. NPTEL Video:https://youtu.be/EjqBdFH5c1A
6. NPTEL Video:https://youtu.be/R-Mq6PCZwq4

ENLIGHTENMENT THROUGH EDUCATION SREC

18NT1E24 NANOWEARABLES 3 0 0 3

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1:	Understand the basics of wearables and nanobiosensors	PO1,PO4
CO2:	Explain the functions of various components of wearables	PO1,PO4
CO3:	Visualize various applications of wearables and their augmentation by nanotechnology	PO1,PO4

SCOPE OF WEARABLES **9**

Textiles and clothing -Agriculture; Pest detection - Soil health monitoring- Cattle rearing; Health monitoring of cattle - Waste management in storage houses -Laboratory hazard management for harmful chemicals - Smart homes; food and water quality monitoring and management- Healthcare; Patient monitoring - Home detection kits

SENSORS IN WEARABLES **9**

Resistive sensors for work safety - Radiation sensors - LASER Safety- Piezoelectric sensors - Accelerometers, Gyroscopes and Pressure sensors for aiding physically impaired stress and strain detection - Packaging sensors- Adulteration sensors - Sweat sensors - Soil Sensors; NPK sensors, pH and Electrical Conductivity of soil - Self sensing cement composites

NANOBIOSENSORS **9**

Biomarkers and food markers; Macromolecules - DNA and RNA based biosensors - Protein and Peptide based biosensors - Electrolyte based biosensors - Pathogen based biosensors - Monoclonal Antibodies synthesis - Lab on a chip

NANOTECHNOLOGY IN WEARABLES AUGMENTATION **9**

Nanomaterials for cancer diagnosis - Nanomaterials for cancer therapy - Nanotechnology in tissue engineering- Nano artificial cells - Nanotechnology in 3D and 4D printed healthcare devices- Smart drug delivery systems

FLEXIBLE WEARABLE ELECTRONICS **9**

Flexible electronics; Flexible power sources -Flexible batteries -flexible displays - Organic electronics -Stress strain connectivity -Muscle movement tracking -- Nanogenerators - Textile and polymer platform - Self healing polymer membranes - Paper based sensors

Total Hours: 45

TEXT BOOKS

1. Enderle J, Blanchard S, Bronzino J, "Introduction to Biomedical Engineering",ElsevierAcademic Press, 2012.
2. Mirkin C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. 2007.
3. Kumar C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact", WILEY -VCH Verlag GmbH & Co., 2005
4. Tong, R., "Wearable Technology in Medicine and Health Care", Elsevier Science., 2018
5. Singh V.K., Singh A.K, Ali Z., Dubey V., Tiwari R., "Design and Optimization of Sensors and Antennas for Wearable Devices", IGI Global, 2019

REFERENCE BOOKS

1. Fraden J, "Hand Book of Modern Sensors: physics, Designs and Applications", 4thedition. Springer, 2010.
2. Webster J. G, "Medical Instrumentation: Application and Design", John Wileyand Sons, 2003.
3. Malsch, N. H., "Biomedical Nanotechnology", CRC Press, 2005
4. Yilmaz N.D., "Smart Textiles, Wearable Nanotechnology", Wiley, 2018

RESEARCH ARTICLES

1. https://www.mdpi.com/2079-9292/11/5/716 (2022)
2. https://www.sciencedirect.com/science/article/pii/B9780128228586000194 (2022)
3. https://link.springer.com/article/10.1007/s00216-021-03602-2 (2021)

ONE CREDIT COURSES

ENLIGHTENMENT THROUGH EDUCATION
SREC

20AEI02 LEAN MANUFACTURING 1001

INTRODUCTION TO LEAN MANUFACTURING **8**

Introduction to seven waste and their narration; Global competition, Lean Manufacturing, Value flow and Muda, Muri and Mura, Need for Lean Manufacturing8

LEAN TOOLS AND TECHNQIUES **4**

Various tool of Lean Manufacturing, Fundamental blocks of Lean, 5S, Kaizen, Poka-yoke, Kanban, Line balancing

TOTAL PRODUCTIVE MAINTENANCE (TPM) **4**

Need for TPM, Pillars of TPM, Implementation of TPM, Overall Equipment Effectiveness (OEE), OEE improvement

VALUE STREAM MAPPING **4**

Sections of VSM - symbols of VSM- Current state mapping, Future state mapping, application of VSM for an industrial process

Total Periods: 20

ENLIGHTENMENT THROUGH EDUCATION SREC

20AEI003	CESSNA 152 AIRCRAFT AND R11F2S300 ENGINE	1 0 0 1

CESSNA 152 **10**

Introduction Cessna 152 A/C specification, Dimensions, Engine, Weight, fuel - Panel Familiarization and Instrument System in Piston Engine Aircraft - Air Frame Systems, Primary Flight Controls - Engine Systems, Engine Controls, Engine Instruments E.g. Airspeed Indicator, Engine Indicator and Fuel System in CESSNA 152Aircraft - Electrical System,Maser Switch, Ammeter circuit Breaker, Vacuum System and Panel Familiarization in CESSNA 152 Aircraft - Ignition and Starter System Primer System CESSNA 152Aircraft - Pitot Static System, Stall Warning, Lighting System - Various Instruments and their functions. - Navigation ADF -Frequency Selection and operating modes, Landing gear, Doors and Exits CESSNA 152 Aircraft RT 359- operating the Transponder, Squawk Identification, Reply Light - Engine Starting - Hot engine Start- Fire Procedures

R11F2S300 Engine **5**

Jet Engine Theory - R11F2S300 Engine Specification -Air Intake Cone, Air Intake Casing, Compressor Casing, Stators, Low Pressure Rotor, High Pressure Rotor - Diffuser Guide Vanes, Combustion Chamber, HP Turbine, LP Turbine, After Burner Diffuser Casing, Jet Pipe Assembly, Jet Nozzle Assembly, Accessory Gear Box, AC Generator, DC Generator, Engine Lubrication Systems, Oil Pump Assembly, Fuel Pump NR21F2, Fuel Pump NR22F2, Electromagnetic Valves, PURT 1F Unit, BU-5 Unit, Engine Bearings

Total Periods: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20BMI001 MEDICAL EQUIPMENTS TRAINING 1 0 0 1

PATIENT MONITORING SYSTEMS **3**

Application of ECG, SPO2, NIBP, IBP, Temp, Respiration, Cardiac Output, Etco2, BIS - Function if each modules used in the patient monitors - ECG methods & Lead wire systems - Different Arrhythmia - Cardiac output methods - Spo2 technology- Etco2(Main stream, side stream, Microstream) measurement and types.

ICU VENTILATOR & ANESTHESIA WORKSTATION OVERVIEW **5**

Respiratory breathing System - Different Blocks of Ventilator - Modes if ventilation (Pressure & Volume) - Simulation demonstration on Ventilator on all modes - Purpose of ICU ventilator & Anaesthesia workstation.

CRITICALCARE EQUIPMENTS TECHNICAL & APPLICATION **5**

Syringe pump & Infusion pump: Different blocks - modes of syringe pump - bolus - purge- Volume, Time & Flow - Internal Parts of Syringe pump. Diathermy: Basics blocks of Diathermy- Monopolar & Bi-polar modes - Internal blocks of Diathermy. Defibrillator: Basics blocks of Defibrillator - Monophais & Biphasic - Different modes - Internal Parts of defibrillator. CPAP: Basic Blocks of CPAP & it's purpose - Internal parts of CPAP.

ROLE OF BIOMEDICAL ENGINEERS IN CRITICAL CARE **2**

Know the technology- Easy Handling - Troubleshooting - Maintenance - Calibration - MIS

Total Periods: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20BMI002 MACHINE LEARNING FOR HEALTHCARE 1 0 0 1

INTRODUCTION TO MACHINE LEARNING AND SCIENTIFIC TOOLS **3**

Overview of different categories of Machine Learning approaches - Regression, Classification, Clustering and Dimensionality Reduction - State of the art Machine Learning approaches in building Artificial Intelligence applications - Scientific computing environment for Machine Learning - Google Colab; Scikit-Learn; TensorFlow Scientific Python - Numpy - Numerical computing library - Matplotlib - Visualization library.

DEEP LEARNING AND REGRESSION ANALYSIS **3**

Introduction to TensorFlow - Shallow and Deep Neural Networks for Regression Analysis - Mean Squared Error as objective function - R-Square goodness of fit for evaluation Prediction using Regression models - Implement Fully Connected Network (FCN) for regression analysis - Predicting sales of product based on budget spent on different advertising media.

CLASSIFICATION USING FULLY CONNECTED NETWORKS **3**

Logistic/Softmax based shallow and deep neural models for classification - Negative-log likelihood / Cross-Entropy objective function Model evaluations - Diagnostic Wisconsin Breast Cancer Database - Binary classification into benign or malignant class - Confusion matrix - Precision, Recall and F1-score.

RECURRENT NEURAL NETWORKS **3**

Models to process sequential data - Different types of Recurrent Neural Networks - Long Short-Term Memory (LSTM) - Gated Recurrent Units (GRU) Time series prediction - ECG Heartbeat Categorization - Multiclass classification based on the time series ECG signal.

CONVOLUTIONAL NEURAL NETWORKS **3**

Feature detection and classifier modules of ConvNets - Convolutions, strides, pooling and FCN building blocks Computer vision applications - Invasive Ductal Carcinoma (IDC) cancer detection from histopathology images - Build a CNN to perform medical image classification.

Total Periods: 15

20BMI003 3D PRINTING FOR MEDICAL AND ROBOTIC USE 1 0 0 1

INTRODUCTION TO ADDITIVE MANUFACTURING AND 3D PRINTING 5

Introduction to additive manufacturing, rapid prototyping, Introduction to 3D printing and various 3D printing technologies, Applications of 3D printing, Illustration of FDM/FFF 3D printers, Applications and case studies of 3D printing. Hands-on with 3D modelling software:Introduction to Computer Aided Designing, Hands-on with open source 3D modelling software and tools for 3D printing.

INTRODUCTION AND HANDS-ON WITH 3D SLICING 5

Introduction to 3D printing and slicing parameters, Hands-on with 3D slicing software, Operating procedures of 3D printers. Medical 3D Printing and Its Applications: Introduction and applications of Medical 3D Printing, Introduction to prosthetics and bionics using 3D printing, Methodology and case studies of 3D printed Bionic arm, Introduction to 3D Bioprinting.

DICOM 3D PRINTING AND SURGICAL PRE-PLANNING 5

Introduction to Medical imaging and formats, Hands-on with converting and processing medical DICOM images for 3D printing, Applications of 3D printing DICOM images. Robotic Applications: Introduction and case studies 3D printed robots, Introduction to 3D printed humanoid robot, Applications of 3D printed robotics

Total Periods: 15

20BMI004 FOUNDATIONS IN CLINICAL RESEARCH

Skyline CRS, CatchU Academy, Coimbatore

Course outcomes:

At the end of the course, the students will be able to

CO1: explain the basic concepts in clinical research process and clinical trial designs

CO2: describe the roles and responsibilities of stakeholders in clinical research

Basic Concepts in Clinical Research

Historical perspectives in clinical research, new drug discovery process, Basic terminology in clinical research (Single blinding, Double blinding, Open access, Randomized, Interventional, Observational & Retrospective study). Types of clinical research (Treatment, Prevention, Diagnostic, Screening, Genetic, Quality of Life and Epidemiological studies).

Regulations Governing Clinical Trials

ICH-GCP guidelines & Indian GCP guidelines, Regulatory authorities in clinical research.

Stakeholders in Clinical Research

Sponsor, Site Management Organization, Clinical/Contract Research Organization, Ethics Committee and Investigator & team

Overview of Clinical Research Process

Designing a protocol, Phases in clinical trials, Post Marketing Surveillance- methods, Principles of sampling, Inclusion and Exclusion criteria, Allocation and randomization methods, Informed consent process, monitoring treatment outcome, Termination of a trial, Safety monitoring in clinical trials.

Documents in Clinical Study: Protocol & Amendment in Protocol, IB, SOP, CRF, ICF, Clinical Trial Report.

Development of Clinical Research Documents

- How to prepare and summit Informed Consent Process
- How to draft a Standard Operating Procedure

TOTAL: 15 Periods

REFERENCES

- Fundamentals of clinical trials. Lawrence MF, Curt DF, David LD, 2010, Springer Science and Business Media.
- Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
- Clinical Trials: A Practical Approach. Stuart J Pocock, 2013, John Wiley and Sons.
- Clinical Trials: A Practical Guide to design, analysis and reporting. Duolao Wang and Ameet Bakhai Remedica, 2006.
- Guidelines: ICH, USFDA, Drugs and Cosmetics ACT, EMA

20BMI005 APPLICATIONS OF IR THERMOGRAPHY IN ENGINEERING

BAMARA Techware (Teledyne FLIR), Coimbatore

COURSE OUTCOME:

Upon completion of the course, the students will be able to

CO1: Explain the basic concepts and applications of IR imaging in engineering

CO2: Capture and analyse IR thermographs in simple applications following best practices

INTRODUCTION TO IR THERMOGRAPHY **7**

Basic Infrared Theory, principle of operation of an infrared camera, principles of heat transfer and its relation to infrared radiation, selecting an infrared camera for your application, Imaging software, image manipulation and artefacts, Calibration. Applications of IR thermography – mechanical, electrical, material inspection, civil and biomedical

CASE STUDIES **8**

Case studies: Human body temperature measurements, thermal profile in electronics,How to do an infrared inspection.Camera handling and image acquisition,Interpreting the IR images ,Data storage and report generation.

TOTAL: 15 Periods

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI001 CONSTRUCTION SAFETY 10 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Analyse the protective measures and standards in construction and their impact on the industry.	PO1,PO2,PO3, PO6,PO7,PO8

Personal Protective Equipment: Protecting Employees- Head Injuries -. Eye Protection - Hearing Protection - Foot Protection - Hand and Body Protection

Falls in Construction: Fall Protection- Personal Fall Arrest Systems -Guardrails and Safety Nets -Skylights and Other Openings-Excavations-Roofs-OSHA's Fall Protection Policies for Residential Construction.

Scaffold: Types/Hazards-Fall Protection - Safe Scaffold Construction - Types of Scaffolds - Inspections- Assembly & Use.

Materials Handling: Hazards -Manual Material Handling - Tunnelling- Mining - Mechanical Handling (Cranes) - Rigging - Stacking and Storing - Erection of Prefabricated structures.

Total Hours:15

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI002 **WATER AUDIT** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify the process of conducting water audit and implement water management measures.	PO1, PO6, PO7

Water system analysis: Monitoring and measurements using pressure and flow meters - Quantification of inefficiencies and leaks - Quantification of water quality loads and discharges - Quantification of variability in flows and quality parameters.

Water management: Strategies for water treatment and reuse or direct use - Complete water balance of the facility - Developing 'recycle' and 'reuse' opportunities - Water consumption and wastewater generation pattern - Specific water use and conservation - Water saving opportunities.

Total hours:15

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI003 GEOTECHNICAL EXPLORATION AND INVESTIGATION 1 0 0 1

COURSE OUTCOMES

On successful completion of this course, the students should be able to

CO1:	Describe the various methods of soil exploration and field testing	PO1, PO2
CO2:	Develop the Bore Log report of given soil profile.	PO1, PO9, PO10

COURSE CONTENT

Site Investigation- Soil exploration techniques- Field testing - Bore hole Investigation - Ground water table determination - Bore Log report preparation from field data - Bearing capacity evaluation for different soil profile - Industrial geotechnical ethics - Preparation of geotechnical approval report- Role of Registered Geo-Technical Engineer.

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI004 DESIGN OF HIGH PERFORMANCE CONCRETE 1 0 0 1

COURSE OUTCOME

On successful completion of the course, students will be able to

CO1:	Describe the construction techniques and methods of placing & curing for high performance concrete.	PO1, PO3, PO6, PO7

COURSE CONTENT

High Strength Concrete and Standard specifications and test methodology for durability concrete-Materials for High Performance Concrete-Properties of HPC- Non-destructive testing methods for HPC strength -RMC - Guidelines for mix proportioning of HPC and Relationships between mechanical properties.

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI005 NON - DESTRUCTIVE TESTING PRACTICES 1 0 0 1

COURSE OUTCOME

On successful completion of the course, students will be able to

CO1:	Illustrate different surface NDE techniques and apply them for inspecting materials in Accordance with industry specifications.	PO1, PO3, PO6, PO7

COURSE CONTENT

Introduction to non-destructive evaluation -Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography- Industrial Applications of NDE- Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions.

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI006 ANALYSIS AND DESIGN OF STRUCTURES 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO 1:	Model the structure, assign properties, apply load and create load combinations for analysis and design	PO1, PO2, PO3, PO5, PO8
CO 2:	Design the structure as per the codal norms and prepare the detailed drawings of the structural components	PO1, PO2, PO3, PO5, PO8

Setting Dimension – Generation of model – Storey Information – Loads and Load combinations – Study of Bending, shear and torsion for beam members –Axial load and biaxial moments for column members – Assigning Design parameters – Design summary results in terms of percentage of reinforcement – Preparation of Detailed Report – Case studies on Residential, commercial and Industrial Structures.

Total Hours: 15

20CEI007 **FIRE SAFETY** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO 1:	Summarize the knowledge of safety in construction equipment, fire, with identification of risk factors and risk zones in the safety management	PO1, PO2, PO3, PO6, PO7, PO8

Introduction to safety management – Need of safety – Fire water demand – Roof line safety - Safety training in the areas of safety auditing, incident reporting, and reporting harmful events – IS Safety codes - Examination of any ISO-accredited safety policies, techniques, equipment, and training of construction company – Protective clothing - Safety during erection and disassembly - Instruction in the safe use of electrical appliances - Scaffolding and work platforms safety – Sizing of pipe line – Storage capacity - Analysis of system safety, and failure modes with impacts in the construction sector. - Firefighting arrangements for residential, commercial and industrial buildings in accordance with the IS Code- NBC Guidelines.

Total Hours: 15

20CEI008 PLANNING AND DESIGN OF INDUSTRIAL STRUCTURES 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO 1:	Analyze the protective measures and standards in construction and their impact on the industry.	PO1, PO2, PO3, PO5, PO8,PO11

Planning of Industrial Structures

Nature of Manufacturing Process-Plant Layout-Space Requirements-Material Handling-Plant Protection-Lighting-Heating, Ventilation and Air Conditioning-Service Facilities-Accessibility-Aesthetic Considerations-Future Expansion

Design Loads & Load Combinationsand Applicable Standards

Dead Load- Live Loads-Collateral Loads-Crane Loads- Equipment Load-Wind Load-Seismic Loads- Codes and Standards

Analysis And Design of Industrial Buildings

Types of Steel Structures- Structural Layout and Framing- Working Stress (ASD)-Limit State (LRFD-Tension Members-Compression Members-Members Subjected to Combined Forces.

Connections

Types of connections – Welded and Bolted – Throat and Root Stresses in Fillet Welds – Seated Connections – Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections.

Total Hours: 15

20CEI009 DAY LIGHTING AND VENTILATION 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline the day lighting and ventilation systems.	PO1,PO2,PO6,PO8

Principles of day lighting design - Day lighting requirements, daylight protractor, day lighting sensors - Glare reduction systems and devices- Sky lighting.

Requirements of ventilation as per ASHRAE / ECBC - Natural ventilation: stack effect, courtyard effect, air changes, ventilation requirement calculations, cross ventilation - Artificial ventilation techniques.

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20CEI010 BUILDING AUTOMATION TECHNIQUES 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify the process of implementing Automation systems and HVAC controls in buildings.	PO1.PO2,PO5,PO12

Building Automation Overview: History of Building Automation Systems (BAS) - Building Types and Key Requirements -| Current and Future Trends - Delivery of BAS.

BAS Applications: Basics of Heating, Ventilation and Air-conditioning (HVAC) in Buildings - Space Condition Controls - Air Handler Controls - Central Utilities - Energy Conservation Control Strategies - BAS Fire/Safety Systems - Security Systems - BAS Surveillance Systems- Energy and water monitoring digital devices, Air quality monitoring.

Total Hours: 15

20CSI001 **NEXTGEN IMAGING** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1 :	Understand the Basic Concepts Context Setting and Next Gen Imaging.
CO2 :	Understand the Fundamentals of Hyper Spectral Imaging and Spectroscopy.

Introduction - Participant Introduction and Involvement Exercise - Context Setting - Expectation Gathering - Computer Vision in the Industry - Next Gen Imaging - Overview - Technologies for Seeing Invisibles: Thermal Imaging - UV Imaging - Spectroscopy - Hyper Spectral Imaging - Hyper Spectral Imaging - Deep Dive -Spectral Signature and Hyper Cube concepts - Tools and Software - Hyper Spectral Imaging - Hands on: Software Installation - Overview - Hands-On Experiments - Hyper Spectral Imaging - Applications of Hyper Spectral Imaging in various business verticals - Overview about the spectroscopy - Single Pixel - Spectroscopy Concepts - hyper spectral imaging - NIR Spectroscopy - Deep Dive and applications - Spectroscopy Hands on Software Installation and Data collection for a small experiment.

Total Hours: 18

ENLIGHTENMENT THROUGH EDUCATION SREC

20CSI002 INTRODUCTION TO DESIGN OF WEARABLE MEDICAL DEVICES 1 0 0 1

COURSE OUTCOMES

On Successful completion of the course students will be able to

CO1:	Knowledge onWearable Medical Equipments
CO2:	Know the Hardware, Firmware & Software design of wearable Medical Device

Course Contents:

MEDICAL DEVICES

- Categories of wearable medical equipments
- Invasive and non invasive
    - Non invasive physiological parameters
    - Requirement gathering/clinical observation
    - Limitations and benefits of wearable devices
    - Design Components
- Hardware design
- Firmware design
- Algorithm development
- Software design
    - Validation, Verification and testing

Total Periods: 18

ENLIGHTENMENT THROUGH EDUCATION SREC

20CSI003 EMERGING TECHNOLOGIES & INNOVATION 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, Students will be able to

CO1:	Know about the emerging technologies & innovation and acquainted with the research approach

Course Contents:

Emerging Technologies

- Technology Trends
- Gartner Hype Cycle and Magic Quadrants

Innovation

- Product, Service, Process
- Disrupt Innovation, Open Innovation
- Technology-Push Innovation and Demand-Pull Innovation

Total Periods: 18

ENLIGHTENMENT THROUGH EDUCATION SREC

20CSI004 FULL STACK DEVELOPMENT 1 0 0 1

Course Outcomes

On Successful completion of the course students will be able to

CO1 :	Know the current development process followed in industries.
CO2 :	Know the best practices followed by industry experts.

Course Contents

Frontend

- MVC - Model Voice Controller
- Modern Programming Frameworks (Angular or React JS)

Backend

- Monolithic vs Microservice
- Architecture & Design Patterns - Decorator pattern, Observer pattern, Singleton pattern
- Programming Paradigms (Imperative or Logical or Functional or Object-Oriented)

Total Periods: 18

20CSI005 HANDS ON MEDICAL IMAGE PROCESSING WITH SIMPLE ITK 1 0 0 1

Course Outcomes

On Successful completion of the course students will be able to

CO1:	Know the Medical Image Processing Techniques
CO2:	Know the Real time implementation of Medical images

Course Contents

- Medical Image Processing Techniques
- Real Time Implementation using SimpleITK library

Total Periods: 18

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

20CSI006 APPLIED MATRIX OPERATIONS 1 0 0 1

Course Outcomes

On Successful completion of the course students will be able to

CO1:	Know the Linear Algebra core concepts & applications
CO2:	Know the applications of Data Science, Machine Learning, Deep Learning and Robotics

Course Contents

- Linear Algebra Real World Applications
- Linear Algebra Core Concepts
- Real world Practical Applications of
    - Data science
    - Machine learning, Deep learning
    - Robotics concepts.

Total Periods: 18

ENLIGHTENMENT THROUGH EDUCATION SREC

20CSI007 DEEP LEARNING &IMAGE PROCESSING USING CONVOLUTIONAL NEURAL NETWORKS (CNN) 1 0 0 1

Course Outcomes

On Successful completion of the course, students will be able to

CO1:	Understand basics of Machine Learning, deep learning and end-to-end process.
CO2:	How to build image classification and object detection models using Tensorflow 2.0.

Course Contents

- Introduction to AI, Machine Learning and Deep Learning
- Types of Machine learning
- Basics of Deep Learning
- Optimizers
- Basics of Image processing
- Convolutions
- Convolutional Neural Networks
- Transfer learning
- End-to-end deep learning process
- Computer vision tasks
- Object detection
- Tensorflow 2.0 (Keras is included)
- Introduction to Google Colab
- Hands-on - build deep learning models for classification and object detection
- Simple convnet from the scratch
- Transfer learning
- Object detection

Total Hours: 18

ENLIGHTENMENT THROUGH EDUCATION SREC

20CSI008 INDUSTRIAL CODING STANDARDS 1 0 0 1

Course Outcomes

On Successful completion of the course students will be able to

CO1:	Understand industrial coding standards to design/develop fail safe system.
CO2:	Knowledge in GNU/Linux toolchain, embedded application design guide, IIoT.

Course Contents

1. C Programming Code Style (MISRA) (Industrial Standards) (Hands-On)
2. GNU/Linux toolchain (Hands-On)

a. GCC

b. MAKE

c. CTAG

d. CSCOPE

3. Git Repository (Hands-On)
4. Embedded Application (Hands-On)

a. Overview

b. Choosing right microcontroller

c. ARM Architecture

d. Fail Safe System

e. IIoT

Total Periods: 18

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

20CSI009 PROGRAMMING TECHNIQUES FOR SUPERCOMPUTERS 1 0 0 1

Course Outcomes

On Successful completion of the course students will be able to

CO1:	ToUnderstand the Programming Techniques for Super Computers.
CO2:	To know the Heterogeneous systems, Distributed systems and HPC Profiling

Course Contents

- Parallel programming concepts
- Fundamentals of shared and distributed memory architecture
- Shared memory programming)
    - Introduction to OpenMP
    - Parallel constructs for CPU programming
    - Parallel constructs for GPU programming
- Distributed memory programming
    - Introduction to MPI
    - Point to point communication
    - Collective communication
- Heterogeneous computing
    - Introduction to heterogeneous architecture
    - Introduction to CUDA and OpenACC (GPU programming)
- Hybrid programming and scalability
- HPC application profiling
    - CPU application profiling (perf tool, mpstat, perf stat, iosta, nmont etc.)
    - MPI profiling and tracing.
    - GPU profiling using NVProf and NVVP.
- HPC benchmarks and case study of HPC application performance analysis (Gromacs, NAMD, CPMD etc.)
- Hands on (Algorithms from Matrix operations (multiplication, transpose etc or kmeans)
- OpenMP, MPI and GPU implementation.

Total Periods: 18

20CSIO12 AGILE - DEVOPS METHODOLOGY 1 0 0 1

Course Outcomes

On successful completion of the course, Students will be able to be

CO1:	Understand Agile Methodology of Software Development
CO2:	Understand DevOps Methodology of Software Development

INTRODUCTION TO AGILE:

Agile Introduction - Agile Manifesto & Principles - Agile Flavours - Classification of Agile Methods - Agile Project Management - Agile Team Interactions - Ethics in Agile Teams - Agility In Design and Testing - Agile Documentations - Agile Drivers, Capabilities and Values.

SCRUM AND SPRINT PROCESSES:

Scrum Basics - Scrum Cycle - Sprint Role - Sprint Planning Meeting - Sprint Review - Sprint Retrospective - Daily Scrum / Standup Meeting - User Stories - Sprint details - Sprint Burndown Chart

INTRODUCTION TO DEVOPS:

Introduction to Devops and Continuous Delivery - A View from Orbit - Release management - Scrum, Kanban, and the delivery pipeline - Wrapping up - a complete example - Identifying bottlenecks - How DevOps affects Architecture - Everything is Code

BUILDING BLOCKS OF DEVOPS:

Building the Code - Testing the Code - Deploying the Code - Configuring the base OS - Describing clusters - Delivering packages to a system - Virtualization stacks - Executing code on the client - Ansible - Deploying with Docker- Comparison tables - Cloud solutions

Total Periods: 18

20EEI001 INDUSTRIAL IoT (USING FULLY OPEN SOURCE) 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the Industrial IoT Architecture (from device to fog to cloud to iSMAC layers)
CO2:	Understand the idea of business transformation using connected car case study - Why you may never buy a car in the near future?
CO3:	Learn the practically explore the concepts behind "Connected Motion".

Module No	Topic	No of Lectures
1	Basics of Industrial IoT	1
1.1	IIoT Architecture Layers	
1.1.1	Introduction to IIoT End Point Gateway, Fog Layer and iSMAC Layers (IoT, Social, Mobile, Analytics and Cloud)	
1.1.1	Difference between traditional SCADA/DCS architectures and IIoT architectures - "Business Transformation Potential"	
2	Introduction to IIoT Business Transformation Potential using Connected Car Case Study	1
2.1	Future of Drives - "Connected Motion"	
2.2	How connected drives will communicate with car's central computer	
2.3	What are the other systems in the connected car - elimination of driver	
2.4	Why should car's central computer communicate with the cloud?	
2.5	Why you may never buy a car in the near future?	
3	Connected Motion	
3.1	Drives & Motion Control in a connected world	1
3.2	Introduction to Industrial Ethernet Protocols - (Profinet, EtherCAT, Ethernet/IP, Sercos, POWERLINK, TSN-OPC-UA, IEEE 802.1)	1
3.3	Introduction to key concepts across different Industrial Ethernet Protocols	1
3.3.1	Concept of Time & Need for Time Synchronization (Atomic Clock, Clock, Drift, Clock Domains, Clock Synchronization, GPS, NTP, PTP, IEEE 1588	1
3.3.2	Scheduling & Traffic Shaping	1
3.3.3	Time triggered sending & Auto-response capabilities to utilize the underlying hardware capabilities fully	1
3.3.4	Concept of Process Data & Service Data & Configuration Tool/Agents	1

Module No	Topic	No of Lectures
3.4	Introduction to open source POWERLINK technology & how it implements the key concepts of real time networking	1
3.5	Introduction to Raspery by Pi POWERLINK - open source open CONFIGURATOR	2
3.5.1	Lab experiments - Raspbery Pi POWERLINK Demo - Remote IO	2
3.5.2	Lab experiments - Raspbery Pi POWERLINK Demo - Distributed Remote IO & Measuring Deterministic Behaviour	2
3.5.3	Lab experiments - Raspbery Pi POWERLINK Demo - Stepper Motor Control	2
3.5.4	Lab experiments - Raspbery Pi POWERLINK Demo - Distributed Motor Control & Measuring Deterministic Behaviour	2

Total Periods: 20

REFERENCE

1. www.kalycito.com/rpi2

ENLIGHTENMENT THROUGH EDUCATION SREC

20EEI002 ENERGY MANAGEMENT AND AUDIT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Demonstrate the philosophy of energy audit and energy management.
CO2:	Explain the different energy management methodologies used to develop an energy audit report.
CO3:	Summarize the types of instruments used for energy auditing and monitoring.

General Philosophy and need of Energy Audit and Management

Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills.

Energy Management Strategy

Energy Audit: Need, Types, Methodology and Approach.

Energy Management Approach: Understanding Energy Costs, Bench marking, Energy performance, matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution.

Energy Audit Reporting

The plant energy study report- Importance, contents, effective organization, report writing and presentation.

Energy Audit Instruments

Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.

Total Periods: 15

TEXT BOOKS

1. Y P Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", Teri Press, 2006.
2. Barney L. Capehart and Wayne C. Turner, "Guide to Energy Management", 7th Edition, Oxford Books, 2011.

20EEI003 SOLAR PV INSTALLATION AND COMMISSIONING 1 0 01

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Recall the principles and applications of Photovoltaic system.
CO2:	Explain the concept of solar passive architecture

SPV SYSTEM DESIGN AND APPLICATIONS 8

Photo voltaic cell - Photo voltaic module - PV array-Solar cell array design concepts - PV system design - Maximum power point stracking - Storage autonomy - Centralized and decentralized SPV systems - Standalone-Hybrid and Grid connected system - System installation - Operation and maintenances - Field experience - PV market analysis and Economics of Solar Photo voltaic systems.

SOLAR PASSIVE ARCHITECTURE 7

Passive heating concepts - Direct heat gain - Indirect heat gain-Thermal storage wall-Attached Green house-Isolated gain and sun spaces - Passive cooling concepts - Evaporative cooling - Shading and ventilation - Radiative cooling - Green coupling - Application of wind - Water and earth for cooling - Paints and cavity walls for cooling-Roofr adiation traps - Energy efficient landscape design.

Total Periods: 15

TEXT BOOKS

1. Sukhatme SP, JK Nayak, Solar Energy, Principle of Thermal Storage and Collection, 3rd Edition, Tata Mc Graw Hill, 2008.
2. Chetan Singh Solanki, Solar Photo voltatics, Fundamentals, Technologies and Applications, PHIL earning Private Limited, 2011.

REFERENCES

1. PeterWürfel, Physics of Solar Cells: From Basic Principles to Advanced Concepts, Wiley-VCH,2009.
2. Jeffrey M.Gordon, SolarEnergy: The Stateof the Art, Earthscan,2013.
3. Garg H.P. and PrakashJ., Solar Energy Fundamentals and application, Tata Mc Graw-Hill Publishing,7th Reprint 2006.
4. Roger A. Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2010.
5. Kalogirou S.A., Solar Energy Engineering: Processes and Systems, 2nd Edition, Academic Press, 2013.

WEB REFERENCES

1. https://en.wikipedia.org/wiki/Solar_power
2. https://en.wikipedia.org/wiki/Solar_energy
3. nptel.ac.in/courses/112105051/
4. www.nptelvideos.in/2012/11/energy-resources-and-technology.html

20EEI004 POWERS EMI CONDUCTORS-CHARACTERISTICS, DRIVING AND APPLICATIONS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the Electrical and Switching Characteristics of Power Semiconductor Devices.
CO2:	Understand the applications and current trends in Power Semiconductor Devices.

OVERVIEW **5**

Types of and classifications - Ratings - Manufacturers - Loss Calculation - Packaging

CHARACTERISTICS **5**

Data sheet understandings - Characterization - single pulse testing

DRIVING **5**

Basics of gate driver unit - General gate drive requirements - Switching characteristics

APPLICATIONS AND CURRENT TRENDS **5**

Major applications of power semiconductors - applications requirements - topologies - current trends in power semiconductors - simulation tools

Total Periods: 20

REFERENCE:

1. RobertWErickson,"FundamentalsofPowerElectronics",SecondEdition,KluwerAcademicPublishers,New York 2001.

20EEI005 INDUSTRIAL AUTOMATION (PLC AND SCADA) 1 0 01

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the need and applications of automation.
CO2:	Learn the practical applications of PLC and SCADA in automation sector.

INTRODUCTION TO INDUSTRIAL AUTOMATION

Automation-Typesofautomation-Needofautomation-Applicationofautomation-Historyofautomation-Toolsof automation-IntroductionofPLC-HistoryofPLC-ArchitectureofPLC-WiringmethodsofPLC-Typesofprogramming language in PLC

LADDER LOGIC PROGRAMMING LANGUAGE

Introduction of ladder logic-Basic elements of ladder logic-Rules of ladder diagram-Logic Gates & Basic programs- Latching concept & Blinking concept - Timers concept - Counters concept - Application Problems Practice - Program Development for Batch Processing System

HARDWARE WIRING CONCEPTS

Control panel wiring-Explanation-Power panel wiring-Explanation-Difference between control & powerpanel wiring- PLC Wiring Types- Selection of power cables-Different type of Switches

PROGRAMMING PRACTICE IN SOFTWARE

Hardware configuration & software introduction-Program Development-Communication between PLC&PC-Uploading & Downloading-Programming Practice in Software

INTRODUCTION TO SCADA - WONDERWARE IN TOUCH

Application Manager - Window Maker - Window Viewer - Basic Screen Development - Scripts & Trends in SCADA

DEVELOPING CONCEPTS

Digital Tags - Analog Tags - Development of Industrial Designs

DEVELOPING CONCEPTS

Creating Basic Animations - Location Property - Filling Property

DEVELOPING & INTERFACING CONCEPTS

Application Problems based on-Movements, Filling-Interfacing with PLC & Application Design Developments-Case Studies

INDUSTRIAL CASE STUDIES & APPLICATION PROBLEMS

Students Queries & Discussion

Total Periods: 15

20EEI006 MAGNETICS 1 0 01

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the fundamentals and applications of to roidal transformer and current transformer.
CO2:	Learn the practical applications of magnetic components.

FUNDAMENTALS OF TRANSFORMER

Working Principle, Classification, EMF Equation, Types. Testing Load Test No load Test - Efficiency Regulation, DCR, Excitation Current & Saturation, Temperature Rise

TOROIDAL TRANSFORMER CONSTRUCTIONS

Construction Basics, Construction Cross Sectional Analysis, Construction Methods and Equipment's used

COMPARISON OF TOROIDAL TRANSFORMER VS CONVENTIONAL EI TRANSFORMER

Comparison Table Design Comparison, Functional Comparison, Dimensional Comparison.

MATERIALS & INSULATION SYSTEM

Insulation class Introduction and Material used for various Class of Insulations. Introduction to International Insulation System Standards

TOROIDAL TRANSFORMER DESIGN FACTORS

Design Parameters, Basic Design Concept, Design Examples, Design RFQ sheet - example

QUALITY REQUIREMENTS OF TOROIDAL TRANSFORMER

Importance Quality needs, Key Features, CTQs, Test Methods, Routine Test and Type Test, Analytical Tools.

CURRENT TRANSFORMER BASICS, CONSTRUCTION, DESIGN & APPLICATION

Current transformer Types Metering Protection, Construction, Application. Current Transformer Testing Accuracy & Linearity and other tests - Introduction: Current Transformer International standards anintroduction.

INDUCTORS AND CHOKES

Inductors applications, AC chokes, DC chokes, EMI Filter chokes, Power Factor Correction and Invertor Chokes, Common Mode Chokes, Inductors Testing. Material used, Construction details.

SPECIAL MAGNETICS COMPONENT

Introduction to Special Magnetics Components & its Application.

PRACTICAL APPLICATIONS MAGNETIC COMPONENTS.

Practical application with examples

Total Periods: 15

20EEI007 E-VEHICLE: THE FUTURE 1 0 01

On successful completion of the course, students will be able to

CO1:	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
CO2:	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
CO3:	Choose proper energy storage systems for vehicle applications
CO4:	Identify various communication protocols and technologies used in vehicle networks.

HYBRID ELECTRIC VEHICLES

IntroductiontoHybridElectricVehicles,ConventionalVehicles,HybridElectricDrive-trains,ElectricPropulsionunit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor, Energy Storage Requirements in Hybrid and Electric Vehicles, Sizing the drive system, Design ofa Hybrid Electric Vehicle, Energy Management Strategies.

Total Periods: 15

TEXT BOOK

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.

REFERENCE BOOKS

1. James Larminieand John Lowry,"ElectricVehicleTechnologyExplained",Wiley,2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E.Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRCPress,2004.

20EEI008 CYBER SECURITY ENABLED IOT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Understand the cyber security fundamentals.
CO2:	Infer the knowledge on Risk Management and Assessment.
CO3:	Learn the applications of IoT.

SECURITY FUNDAMENTALS

Social Media and Cyber Security Fundamentals-IT Act- CNCI - Legalities

Cyber Attack and Cyber Services Vulnerabilities - Phishing - Online Attacks. - Cyber Attacks - Cyber Threats - Denial of Service Vulnerabilities - Server Hardening

RISK MANAGEMENT AND ASSESSMENT

Risk Management Process - Threat Determination Process - Risk Assessment - Risk Management Lifecycle - Vulnerabilities, Security Policy Management - Security Policies - Coverage Matrix, Business Continuity Planning - Disaster Types - Disaster Recovery Plan - Business Continuity Planning - Business Continuity Planning Process.

APPLICATIONS OF IOT

Smart HOME - Smart Agriculture - Smart Grid, Phasor Measurement, Information Transfer, Distributed Generation - Function of IIoT components, Challenges in IIoT.

Total Periods: 15

20ECI001 INTRODUCTION TO AUGMENTED REALITY 1 0 0 1

Course Outcomes

On Successful completion of the course students will be able to

CO1:	Understand AR app development concepts.
CO2:	Deploy their AR appon Android and iOS devices.
CO3:	Knowledge in the main application of AR technologies in education, medicine and surgery, cultural heritage, IOT and games.

Course Content:

1. Introduction to Augmented Reality
   - About Augumented Reality
   - Augumented Reality vs Virtual reality vs Mixed Reality
   - How Augumented Reality works
   - Types of Augumented Reality
   - AR Applications and AR Development tools
2. Introduction to Unity and Vuforia
   - Vuforia API Configuration with Development Portal.
   - Introduction to Vuforia Targets and its differences
   - Configure our first API with Unity
   - Introduction to Unity Editor
3. Creating your First Unity Project
   - Creating our First Project
   - Working with 3D Models(Position, Scaling and Rotation)
   - Working with Materials.
4. Scripting with C#and Setting up Vuforia
   - IntrotoC#Scripting
   - AddingScriptswithModels
   - Scripting with Rigid BodiesandPhysics
   - ConfiguringVuforiawithapi key
   - CreatingImageTargets
   - Working with Image TargetsandARCamera
   - Working with 3D Models(scalingandRotation)
5. AR Visiting Card Project- Project 1
   - Setting up the Project and AR Stage.
   - Working with UI Component.
   - Working with Video playback on Image Target.
   - Working with UI Components and adding Script components.
   - Implementing Virtual Buttons.
6. CreatingSmartBookProject-Project2
   - Creating Multiple ImageTargetsandDatabases
   - Working with differentmodels
   - Adding sounds andAnimation with backendscripting
7. Visualizing Sensor data using AR (IOT) - Project 3
   - Formingcircuit with Arduino, Wifi/LAN moduleandSound Sensor
   - Transmittingsensordatatothe cloud server
   - CreatingnewUnityprojectand fetching data from theserver and displaying datausingUnity GUI

20ECI002 REVERSE ENGINEERING WITH SENSORS 1 0 0 1

Course Structure

1. Sensor Technology Overview
    - What are sensor / transducer?
    - Classification of sensors
    - Sensor technology
    - Application of sensors
2. Practical/Hand-on Session
    - Getting started with sensors with reverse engineering
    - IR proximity sensor
    - Ultrasonic distance sensor
3. Sensor Measurement Techniques
    - Sensor data acquisition
    - Signal conditioning processes
    - Analog to digital converter (ADC)
4. Test challenges for smart sensors.

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20ECI003 MACHINE LEARNING - APPLICATION PERSPECTIVE 1 0 0 1

Course Outcomes:

On Successful completion of the course students will be able to

CO1:	Identify how technology have developed to enable ML.
CO2:	Classify the algorithms for ML.
CO3:	Design and implement some basic machine learning algorithms using tools.

Introduction to Machine Learning **7 hours**

Introduction- Basic concepts-Well-Posed learning problems- Designing a learning system-Issues in machine learning. Types of machine learning: Learning associations. Supervised learning- Unsupervised Learning - Reinforcement Learnings.

Application Programming for Machine Learning **8 Hours**

Python Programming for ML- Mean, Median, and Mode- Standard Deviation, Percentiles Data Distribution- Normal Data Distribution- Scatter Plot. Linear Regression- Polynomial Regression- Multiple Regression- Applications- CoreML- Testing -Training and Applications.

Teaching form

Teaching consists of Hands on experience in Programming ML concepts , exercises, project, and home assignments. Each Module is accompanied by a mandatory assignment for students to be worked on individually as well as in groups. Assignments that have to be worked on in groups are afterwards presented in front of class

TEXT BOOKS & REFERENCES

1. Muller Andreas , Introduction to Machine Learning with Python - A Guide for Data Scientists.

REFERENCES

2. Alex Smola and S.V.N. Vishwanathan , Introduction to Machine Learning , Cambridge University Press
3. Nilsson N.J., Introduction_to_machine_learning, Stanford University.
4. Kubat Miroslav, An Introduction to Machine Learning ,Springer International .

Total Hours: 15

20ECI004 LORA GATEWAY DESIGN & APPLICATION 1 0 0 1

Course Outcomes:

On Successful completion of the course students will be able to

CO1:	Identify how technology have developed to enable ICT.
CO2:	Classify the standards for LoRa
CO3:	Design and Test LoRa Gateway
CO4:	Identify the role of LoRa and LoRaWAN in Smart Cities

INTRODUCTION TO LORA **8**

Introduction to LoRa -Radio Communication - Frequency Spectrum-Licensed and Unlicensed-Available Wireless Technologies and need for LoRA- Class A, Class B , Class C operation- Radio Propagation- Power-Frequency-Bandwidth - AFC- BT product- LoRa Modulation- Chirp Spread Spectrum -Spreading Factor- Window Length - Transmission/Reception time.

LoRA GATEWAY CONFIGURATION **7**

MAC Configuration-Channel Number/Frequency- Data Rate Selection- Gateway Parameters- Ip allocation-Up/Down Ports- Polling Rate- Polling Behaviour- base- Network Session Key- Application Session Key - Downlink- Queue - Application Testing.- Microchip- Semtech -mbed -Kerlink-Multitech-gateway-comparison-selection- Case Studies- LoRaWAN design Thinking.

REFERENCES

1. http://ww1.microchip.com/downloads/en/devicedoc/40001847a.pdf
2. https://lora-alliance.org/sites/default/files/2018-04/lorawantm_regional_parameters_v1.1rb_-_final.pdf
3. https://lora-alliance.org/sites/default/files/2018-04/lorawantm_specification_-v1.1.pdf
4. https://www.semtech.com/lora/lora-applications
5. https://www.loriot.io/lora-gateways.html

Total Hours: 15

20ECI005 EMBEDDED COMMUNICATION PROTOCOLS 1 0 0 1

Course Outcomes:

On Successful completion of the course students will be able to

CO1:	Know the need of Embedded Communication Protocols
CO2:	Understand and Programming UART | I2C | SPI | CAN

Course Contents:

1. Introduction to Serial Communication using UART
    - Types of Serial Communication
    - Rules of Serial
        - Baud Rate
        - Framing the data
        - Parity bits
2. The Physical Layer Standards
    - TTL level UART
    - RS-232 Basics
        - Voltage Levels
        - RS-232 Level Converters
    - Baud Rate Calculation
3. Programming UART in MCU to Communicate with PC
4. Introduction to communication protocols
    - Serial & Parallel Communication
    - Why I2C is Required
    - I2C Bus characteristics
    - Hardware Details
    - Electrical Aspects
5. Data Transfer
    - I2C Addressing
    - Data Frame Formats
    - 10 Bit Addressing
    - Repeated Start Condition
6. Understanding the Slave Device
    - Memory Organization
    - Device Addressing

ENLIGHTENMENT THROUGH EDUCATION SREC

- Write & Read Operations
- Interfacing &Programming I2C based EEPROM

7. Introduction to SPI Protocol
   - Data and Control Lines of the SPI and the Basic Connection
   - How do they communicate?
   - Different types of configurations
8. Understanding the Slave Device
   - Significance of the Clock Polarity and Phase
     - Mode 0
     - Mode 1
     - Mode 2
     - Mode 3
   - Pin Assignment
9. Interfacing SPI based Graphic LCD Display Interface
10. Introduction to CAN
    - History of CAN
    - Features of CAN
    - CAN Standards
    - CAN Bus Characteristics
11. CAN Frame Formats
    - Data Frame
    - Remote Frame
    - Overload Frame
    - Error Frame
12. Errors in CAN

Establishing CAN Communication network between two controllers

Total Hours: 15

20ECI006 PCB DESIGN AND FABRICATION 1 0 0 1

Course Contents:

Session -1&2

- Introduction to Electronic Design Automation (EDA) Introduction to Industrial
- Design Tools and Specifications Component Introduction and Categories
- Overview of PCB Terminology Library Standards
- PCB Design Flow

Session-3&4

- Introduction to EAGLE software Schematic Capture and Demo
- Schematic Verification
- Classes of PCB Design
- PCB Layout Stack-up and Standards

Session-5&6

- Component Placement Guidelines Design Rules Management
- Routing Guidelines
- Layout Planning and Designing (Single & Multi Layer Board's) PCB Routing - Sample Design

Session-7&8

- Impedance Control
- Design Verification
- DFM and DFA Standards
- Manufacturing Output Generation (BOM, Gerber's)

Session-9&10

- Overview of ETS PCBMATE Prototype Machine Introduction to CNC Machine Controller Software Gerber to G-CODE **Conversion**
- Demo Board Printing

Total Hours: 15

Embedded System Overview
Architecture & Characteristics for Embedded System, Types, Examples of Embedded System, Embedded SOC.

Embedded System Software
Operating System concepts, RTOS, Different OS task, Selection Criteria, Boot loader,

Sensor, Actuators, and Interfacing
Sensors, Actuators , Interface techniques, Embedded System Application Development (Lab work)

IOT
Introduction to IOT with Case Studies

Communication under IOT

MQTT, CoAP, XMPP and AMQT, IoT communication models, IoT Communication technologies: Bluetooth, BLE, Zigbee, Zwave, NFC, RFID, LiFi, Wi-Fi, Interfacing of wifi, RFID, Zigbee,NFC with development board Lab Work Application development

20ECI008 CONNECTED CAR- ELECTRONICS 1 0 0 1

The purpose of this course is to teach the students fundamental requirements and challenges of, Automotive Electronics, ADAS, Connected Cars and how to integrate such technology into existing cars for making connected cars.

PREREQUISITE

Basic Electronics and Circuits.

INSTRUCTIONAL OBJECTIVES

1. To familiarize with Automotive electronics and Protocols used.
2. To Identify the main challenges associated with Autonomous Cars.
3. To familiarise with connected cars and its applications.
4. To identify the requirements of OBD.
5. To develop application modules for Connected Cars and Smart Cars.

OUTCOME

Learners should be able to

1. Identify how technology have developed to enable Autonomous Cars.
2. Classify the standards for V2V Applications.
3. Design and Test OBD Product.
4. Identify the role of Sensors in ADAS
5. Become familiar with the various types of Advanced driver assistance systems

Module 1 **7 hours**

Introduction-Automated-Connected and Intelligent Vehicles - Automotive Electronics -Overview CAN-UDS protocol - ECU operation- Networking of ECU-OnBoard Diagnostics- Advanced OBD -Failure Modes and Self Calibration- Real Time On Board Parameters- Cloud Connectivity- Testing and Validation

Module 2 **8 hours**

Connected Car Technology - Connectivity Fundamentals M2M- V2V-V2I- ETSI Standards for V2V. Navigation and Other Applications -ADAS- Sensor Technology for Advanced Driver-Assistance Systems - Basics of Radar - LIDAR- Camera -Ultrasonic Sonar-Technology and Systems Integration of Sensor Data to On-Board Control Systems.

Teaching form

Teaching consists of Hands-on experience with OBD- Connected Kits designed for Development.exercises, project, and home assignments.

Grading Schedule -

Each Modules is accompanied by a mandatory assignment for students to be worked on individually as well as in groups. Assignments that have to be worked on in groups are afterwards presented in front of class Final Assessment format as per the institution demand.

TEXT BOOKS & REFERENCES

1. Automotive Embedded Systems Handbook, CRC Press, ISBN 9781498797986.
2. Hermann Winner, Handbook of Driver Assistance Systems, Springer International Publishing Switzerland 2016- https://doi.org/10.1007/978-3-319-12352-3.
3. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, Vieweg, 2014. ISBN 978-3-658-01784-2
4. Understanding Automotive Electronics-An Engineering Perspective, W B.Ribbens, Elsevier, ISBN: 978-0-08-097097-4.

20ECI009 **DIGITAL TWIN** **1 0 0 1**

Understanding Digital Twin

History of the Digital Twin - Industry use of Digital Twins - The value proposition of Digital Twins - Identifying opportunities - Key criteria - Expected business outcomes - Prerequisites for the Digital Twin - Organizational factors - Technological needs.

Introduction to Unity and Scripting

Creating our First Project - Working with 3D Models(Position, Scaling and Rotation) - Working with Components - Adding Scripts with Models - Scripting with Rigid Bodies and Physics - Working with Lights

Working with 3D Objects, Animations and UI

Importing 3d Models - Simple Animation Controller - Working with UI Components - UI Scripting

The Arduino, IDE Tour and Programming

History of the Arduino - Touring the Arduino UNO R3 - Powering the Arduino - Arduino shields Arduino pin - Arduino Sketch - Arduino IDE - Arduino web editor - Examples - Arduino libraries - Serial monitor - Arduino Programming Basics

Working with Environment Sensors

Introduction - Components needed - Circuit diagrams - Code - Running the project - Challenge

Web API and JSON

Introduction to JSON - JavaScript Object Notation - Data Types in JSON - Fetch JSON File Data - Array of Items JSON - Nested JSON Data Output - Nested JSON Challenge - Web JSON APIs using JSON

Arduino, Rest API and Unity

Writing API Service - IOT Data and Json - Reading API data in unity - Deserializing json data

First Digital Twin Project

Technical requirements - Development process of our Digital Twin - Digital twin 3D model - Behavioral scripting based on the JSON data- Testing framework - Technical evaluation considerations

Spline Digital Twin Robot - Final Project

20ECI010 **ANTENNA ENGINEERING** **1 0 0 1**

Objectives:

1. Introduce the various concept of antenna design.

2. Familiarize the students with the application of different type of antennas

Learning Outcomes:

The students are expected to have the ability to:

1.Design low profile antennas and high gain antenna arrays for practical applications

2.Utilize ANSYS HFSS simulation software for designing Antenna systems

Contents

- Introduction to Antennas: Radiation mechanism, Current distribution on an antenna,
- Review of Antenna Parameters; Friis Transmission formulae.
- Design of half-wavelength dipole.
- Micro strip antenna rectangular patch antenna, feeding methods.
- Design of Antenna Arrays Analysis of Two element array, N-element linear array.

20EII001 AUTOMATION AND CONTROL 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Summarize different techniques for industrial automation	PO1,PO2,PO5
CO2:	Make use of PLC for the automation of industries	PO1,PO2, PO5
CO3:	Acquire knowledge on design and implementation of a SCADA	PO1,PO2, PO5

AUTOMATION **5**

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system- Manufacturing plants and operations- Industrial control Systems- Process-Discrete manufacturing industries- Final control elements-Industrial drives

PROGRAMMABLE LOGIC CONTROLLERS (PLCs) **5**

Programmable logic controllers, Analog, digital input and output modules, PLC programming: Ladder logic, functional block diagram - PLC Communication and networking-Error debugging-PLC selection-PLC Installation-Application of PLC in process industries.

SUPERVISORY CONTROL SYSTEMS (SCADA) **5**

SCADA System Components-SCADA Architecture-SCADA Communication-SCADA Applications-Creating SCADA project - Creating & editing elementary graphic display - Attaching controls to graphic objects - Real time & historical trends - Using alarms & events - Application of scripts - Communication with PLC-DCS and SCADA Comparison

Total Hours: 15

20EII002 MACHINE LEARNING FOR INSTRUMENTATION-APPLICATION PERSPECTIVE 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify the main challenges associated with ML	PO1,PO2,PO5
CO2:	Develop application modules for ML in Instrumentation.	PO1,PO2, PO5

FUNDAMENTALS OF MACHINE LEARNING **8**

Basic concepts-Well-Posed learning problems- Designing a learning system-Issues in machine learning. Types of machine learning: Learning associations. Supervised learning- Unsupervised Learning - Reinforcement Learnings.

APPLICATION PROGRAMMING FOR SUPERVISED INSTRUMENTATION **7**

Online Monitoring requirements and Applications.- ML for Online Monitoring- Data Distribution-Scatter Plot. Linear and Polynomial Regression- Multiple Regression- Scale-Decision tree -Error Metrics -Error Diagnostics - Error Filtering. Online Instrumentation design and testing

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20EII003 QUALITY CONTROL AND INVESTMENT PORTFOLIO MANAGEMENT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Acquire knowledge on quality control	PO1,PO9,PO11,PO12
CO2:	Infer the concepts of portfolio management	PO1,PO9,PO11,PO12

QUALITY CONTROL **8**

Quality Control-Need of Quality in industries or Software verticals-Quality Control Techniques and stages involved-Objectives or Philosophy of QC

INVESTMENT PORTFOLIO MANAGEMENT **7**

Portfolio Management - Types of Portfolio Investments - Significances and Advantages of Investment Portfolio-Strategies on investments

Total Hours:15

ENLIGHTENMENT THROUGH EDUCATION SREC

20EII004 **SENSORS AND ITS APPLICATION IN INDUSTRIAL AUTOMATION** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Acquire knowledge on industrial automation sensors	PO1,PO2
CO2:	Relate the types of industrial automation sensors	PO1,PO2
CO3:	Make use of development in sensors for future technologies	PO1,PO2

FUNDAMENTALS SENSORS3

Sensors - Sensor classification - Static characteristics - Dynamic characteristics.

DISPLACEMENT ,PRESSURE SENSORS AND FLOW SENSOR **2**

Potentiometers - Strain Gauges -LVDT - Capacitive Type sensors-Pressure Sensors - Diaphragms, Bellows,differential pressure sensor-Flow sensor - MASS flow meter, turbine flow sensor, oval gear sensor

TEMPERATURE SENSORS AND MAGNETIC SENSORS **3**

Thermistors - Thermocouple -Resistive Temperature detector - Radiation Thermometry; Magnetic sensors

LOAD SENSOR AND TORQUE SENSOR **2**

Torque sensor and Load sensor-Tension, compression, bending and alternating sensor

BIOSENSORS **5**

Blood gas and Acid - Base Physiology, Electrochemical sensors, reference electrode, pH, pO2, pCO2 electrodes, Ion-Selective Field - Effect Transistor (ISFET), Noninvasive Blood-Glucose Sensors.

Total Hours:15

20EII005 INDUSTRIAL PNEUMATICS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Interpret the air compressor and service unit in pneumatic systems
CO2	Outline the types and selection criteria for air compressors
CO3	Infer the working principle of different valves and accessories used in pneumatic systems
CO4	Explain the pneumatic and electro-pneumatic circuits.
CO5	Develop a system using pneumatics'and actuator's for an application.

AIR COMPRESSOR AND SERVICE UNIT **5**

Requirements for Pneumatic System-Applications -Types & Selection criteria for Air Compressors-Air receiver-Pipeline Layout-Air filter -Pressure regulator and Lubricator (FRL unit).

PNEUMATIC CYLINDERS, MOTORS AND VALVES **5**

Types of Pneumatic Cylinders and Air motors-Cushion assembly-Mounting arrangements- Pneumatic Direction control valves-Quick exhaust-Time delay Shuttle and Twin pressure valves.

PNEUMATIC CIRCUITS **7**

Basic pneumatic circuits-Development of single Actuator Circuits-Development of multiple Actuator Circuits-Cascade method for sequencing

Total Hours: 17

20IT2I02 MOBILE WEB APPLICATION DEVELOPMENT WITH COLDFUSION 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Fundamental understanding on Web App Architecture.
CO2:	Have a clear understanding on implementing Bootstrap to design web pages.
CO3:	Troubleshoot the application logs to find out where the errors are and how to correct them.
CO4:	Understand and Implement ACID properties in multilevel transactional processing.
CO5:	Have a fundamental understanding of Web Services.

INTRODUCTION TO MOBILE WEB APPLICATION DEVELOPMENT

HTML5 Semantics - Design Elements - Form Elements - Post Form - Get Form - CSS3 Introduction - Media Queries - Border Radius - BootStrap Library.

INTRODUCTION TO COLD FUSION

Application Server - Database Server - Page Life Cycle - Versions and Types of ColdFusion - Installation and Configuration - Install ColdFusion - Configure a Web Site.

SQL

Database Server - Introduction to MySQL - Installation and Configuration - CRUD Operations - PSQL Statements.

APPLICATION DEVELOPMENT

Fundamentals of Application Development - Page Design - Database Operations - Building a Web Service - Tag based Application Development.

Sailing with ColdFusion cfsilent - cfform - cfif - cfoutput - cfloop - cfcomponent cffunction - cfargument - cfquery - cfqueryparam - cfreturn - cftry - cfcatch - cflog - cfmail.

Total Hours: 20

REFERENCES

1. Programming ColdFusion MX, 2nd Edition Creating Dynamic Web Applications By Rob Brooks-Bilson Publisher: O'Reilly Media.
2. Learning MySQL Get a Handle on Your Data By Seyed M.M. Tahaghoghi, Hugh E. Williams Publisher: O'Reilly Media.

WEB REFERENCES

1. http://www.adobe.com/in/products/coldfusion-family.html
2. http://lucee.org/
3. https://www.mysql.com/

20IT2I03 IBM CLOUD PRIVATE WITH LINUX ON Z SYSTEMS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Study IBM Mainframe server, IBM z Linux and IBM Cloud Private.
CO2:	Study the benefits of a public cloud on a security-rich, scalable private cloud platform for developing and delivering cloud-native apps.
CO3:	Understand all these concepts connecting to the real world scenarios about these technologies.

INTRODUCTION TO MAINFRAME **4**

Introduction to the new mainframe - What is a mainframe - Who uses mainframe computers - Introducing the Mainframe zEnterprise System - Mainframe hardware architecture - Processor units - Networking and Memory - Disk devices - Typical mainframe workloads - Roles in the mainframe world - z/OS and other mainframe operating systems - Reliability, availability, and serviceability.

VIRTUALIZATION IN MAINFRAME **4**

Introduction to Virtualization - Virtualization benefits - Server virtualization techniques - Mainframe virtualization technologies - Mainframe virtualization - Storage virtualization - Introduction to the New Mainframe: z/VM Basics - Mainframe RAS OS perspective, CDU, Channel Sub System Overview.

IBM Z LINUX **3**

IBM z Linux Introduction - IBM LinuxONE - Heavy workloads and thousands of Linux servers in one box.

IBM CLOUD PRIVATE **3**

The IBM Cloud Private Introduction - Public and Private Clouds - Protecting Kubernetes and Docker workloads - Microservice-based apps - Hybrid Cloud.

CASE STUDY: IBM CLOUD PRIVATE OFFERINGS **4**

IBM Cloud Private Offerings - Making ICP Real for Business - IBM z14 and IBM Cloud Private.

Total Hours: 18

REFERENCES

1. Introduction to the New Mainframe - http://www.redbooks.ibm.com/redbooks/pdfs/sg246366.pdf
2. IBM Systems Virtualization: Servers, Storage, and Software-http://www.redbooks.ibm.com/redpapers/pdfs/redp4396.pdf
3. Introduction to the New Mainframe: z/VM Basics - http://www.redbooks.ibm.com/redbooks/pdfs/ sg247316.pdf
4. IBM z, Linux ONE and IBM Cloud Private - www.ibm.com/

20IT2I04 BLOCKCHAIN ON IBM MAINFRAME 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand IBM Mainframe server, IBM Secure Service Container and IBM Blockchain offerings connecting to the real world scenarios about these technologies

INTRODUCTION TO MAINFRAME **4**

Introduction to the new mainframe - What is a mainframe - Who uses mainframe computers - Introducing the Mainframe zEnterprise System - Mainframe hardware architecture - Processor units - Networking and Memory - Disk devices - Typical mainframe workloads - Roles in the mainframe world - z/OS and other mainframe operating systems - Reliability, availability, and serviceability

VIRTUALIZATION IN MAINFRAME **4**

Introduction to Virtualization - Virtualization benefits - Server virtualization techniques - Mainframe virtualization technologies - Mainframe virtualization - Storage virtualization - Introduction to the New Mainframe: z/VM Basics - Mainframe RAS OS perspective, CDU, Channel Sub System Overview.

SECURE SERVICE CONTAINER (SSC) **3**

Container Technology Introduction - Appliances Details - Secure Service Container Framework Overview - Secure Service Container Protection - Need for Secure Service Container

IBM BLOCKCHAIN APPLIANCE IN Z **3**

The Blockchain Appliance - zBlockchain Appliance - High Secure Business Network (HSBN) - Running Blockchain Appliance in Secure Service Container

CASE STUDY: IBM BLOCKCHAIN OFFERINGS **4**

IBM Blockchain Offerings - Making Blockchain Real for Business - IBM z14 and the new revolutionary transaction model

Total Hours: 18

REFERENCES

1. Introduction to the New Mainframe - http://www.redbooks.ibm.com/redbooks/pdfs/sg246366.pdf
2. IBM Systems Virtualization: Servers, Storage, and Software - http://www.redbooks.ibm.com/redpapers /pdfs/redp4396.pdf
3. Introduction to the New Mainframe: z/VM Basics -http://www.redbooks.ibm.com/redbooks/pdfs /sg247316.pdf
4. Blockchain transactions on Z - https://www.ibm.com/itinfrastructure/z/capabilities/blockchain-transactions

20IT2I05 iOS APP DEVELOPMENT BASICS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the basics of Mobile Application development and iOS.
CO2:	Develop iOS application using UI components.

INTRODUCTION TO MOBILE APPLICATION DEVELOPMENT AND IOS BASICS 7

Introduction to Mobile App Development - Web Development vs Mobile App Development - Hybrid App Development vs Native App Development - Short comparison on Android and iOS Appdevelopment - Introduction to iOS - iOS App restrictions and guidelines (Apple's recommendation).

AutoLayout - Screen orientations - Sample program to explain the use of AutoLayout.

NAVIGATION CONTROLLER, VIEW AND ITS IMPORTANCE 8

Overview about Navigation Controller and Segue and stack - Navigation Controller stack - Passing data between controllers - Delegate and Notification Centre - Design Pattern (Observer Pattern, Singleton Pattern, and Delegate Pattern)

ScrollView - TableView manipulations - Dispatcher - Queue operations - Illustration with image loading - CollectionViews - CollectionView's manipulations - Distinguishing TableView vs CollectionView.

Device permission - ImagePickerController usage.

Total Hours: 15

TEXT BOOKS

1. Jonathon Manning, Paris Buttfield - Addison, "Learning Swift: Building Apps for macOS, iOS, and Beyond", 3rd Edition, Shroff/O'Reilly publishers, 2018.
2. Matthew Knot, "Beginning Xcode: Swift Edition", 2nd Edition, Apress, 2014.

REFERENCES

1. SerhanYamacli,"Beginner's Guide to iOS 12 App Development Using Swift 4: Xcode, Swift and App Design Fundamentals", Createspace Independent Publishing Platform, 1st Edition, 2018.
2. Matt Neuburg, "Programming iOS 9 - Dive Deep into Views, View Controllers, and Frameworks, Shroff Publishers", 1st Edition, Kindle, 2015.

WEB REFERENCES

1. https://developer.apple.com/library/archive/referencelibrary/GettingStarted/DevelopiOSAppsSwift/
2. https://docs.swift.org/swift-book/GuidedTour/GuidedTour.html
3. https://developer.apple.com

20IT2I06 ETHICAL HACKING AND CYBER SECURITY 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify and analyse the stages an ethical hacker requires to take in order to compromise a target system.
CO2:	Identify tools and techniques to carry out penetration testing.
CO3:	Critically evaluate security techniques used to protect system and user data.
CO4:	Demonstrate systematic understanding of the concepts of security at the level of policy and strategy in a computer system.

ETHICAL HACKING AND SECURITY TECHNIQUES

Introduction to Ethical Hacking - Introduction to Networking - Introduction to Linux - Cyber Security Laws Footprinting & Reconnaissance - Footprinting counter measures - DNS - Web Vulnerability - Key Logger - Deep, Dark & Surface Web - Password Cracking & Security - XSS Cross side scripting - Working in TOR - Sniffing - DNS Spoofing - Information Gathering - SQL Injection - Setting up VPN Server - DOS 7 DDOS attack - BurpSuit - Addon Creation - Social Engineering - Cryptography - Wireshark - Android App Hacking - Cookies Stealing - Click Jacking , Tab-nabbing & Session Hijacking - Case Studies.

Total Hours: 20

REFERENCES

1. Hein Smith, Hilary Morrison, "A Comprehensive Beginner's Guide to Learn and Master Ethical Hacking", Kindle Edition.
2. Dafydd Stuttard, Marcus Pinto, "The Web Application Hacker's Handbook Discovering and Exploiting Security Flaws", 2011.
3. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide", 2014.

20IT2I07 ARTIFICIAL INTELLIGENCE 1 0 0 1

PREREQUISITES

Knowledge of any advanced programming language (Java, Python etc.,), Algorithms and Data structures, Elementary Discrete Mathematics or similar.

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Identify problems that are amenable to specific solution by appropriate AI methods.
CO2:	Understand and explore knowledge representation techniques and problem solving strategies to common AI applications.
CO3:	Design good evaluation framework functions for different problem solving strategies.

INTRODUCTION:

What is AI through examples, Definition, History, Agents, Structure of Agents, Problem Solving Agents. Problem solving search approaches: Search, Search Space, Tree based search [DFS, BFS], Dynamic Programming with and without memory, Staircase problem, rod/wood/diamond cut problem, Constraint satisfaction problem.

KNOWLEDGE REPRESENTATION ISSUES:

Representations and mappings, approaches to knowledge representation, issues in knowledge representation, using predicate logic: simple facts in logic. A simple lab session using Graphs/OWL/RDL, Learning Problems: LR, Learning Decision Trees, Ensemble learning, NLP, Logic programming, fuzzy logic and probabilistic reasoning in brief, Mini AI activity Design of a real world problem.

Total Hours: 16

TEXT BOOK

1. Stuart Russel, Peter Norvig: Artificial Intelligence - A Modern Approach, 3rd Edition, Pearson Education, 2012.

REFERENCES

1. Elaine Rich, Kevin Knight, Shivashankar B Nair: Artificial Intelligence, 3rd Edition, Tata McGraw Hill, 2011.
2. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
3. Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.

WEB REFERENCE

1. http://nptel.ac.in

20IT2I08 BLOCKCHAIN AND ENTERPRISE APPLICATIONS 1 0 0 1

PRE REQUISITE

20IT208 - Data Communication and Networks

CO1:	Understand the mechanism involved in Blockchain and the functionality associated	PO1, PO2
CO2:	Learn the fundamentals of Cryptographic Background	PO1,PO2,PO4
CO3:	Understand the principles of cryptographic algorithm for Blockchain transactions	PO1,PO2,PO4
CO4:	Understand the basics of cryptocurrency in Blockchain	PO8, PO12
CO5:	Understand the Blockchain protocols and regulations	PO6, PO8, PO12

COURSE CONTENT

Introduction to Cryptography - Introduction to Ledgers - Hashing in blockchain - Centralization vs Decentralization-Introduction to NFT-Cryptography in blockchain - Linking blocks - Introduction to Blockchain - History of blockchain - Blockchain functionality- Characteristics of Blockchain -Features of Cryptography- Linking blocks using SHA - Consensus with- out identity using a blockchain - Difference of blockchain with database -Types of Cryptography Algorithms - Block structure - Symmetric Cryptogrphy- Asymmetric Cryptogrphy - Creating blockchain- Introduction to Smart Contracts-Digital signature in blockchain- Sample architecture- Tokens - Hash Pointers - Types of Blockchain - Asset ownership in blockchain - Overview of blocks, Block attributes - Transferring an asset - Applications of Blockchain.

Total Hours: 16

REFERENCE

1. Blockchain Revolution: How the Technology BehindBitcoin is Changing Money, Business, and the World, 2016.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc22_cs44/
2. https://www.coursera.org/specializations/blockchain

20IT2I08 BLOCKCHAIN AND ENTERPRISE APPLICATIONS 1 0 0 1

PRE REQUISITE

20IT208 - Data Communication and Networks

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Understand the mechanism involved in Blockchain and the functionality associated	PO1, PO2
CO2:	Learn the fundamentals of Cryptographic Background	PO1,PO2,PO4
CO3:	Understand the principles of cryptographic algorithm for Blockchain transactions	PO1,PO2,PO4
CO4:	Understand the basics of cryptocurrency in Blockchain	PO8, PO12
CO5:	Understand the Blockchain protocols and regulations	PO6, PO8, PO12

COURSE CONTENT

Introduction to Cryptography - Introduction to Ledgers - Hashing in blockchain - Centralization vs Decentralization - Introduction to NFT - Cryptography in blockchain - Linking blocks - Introduction to Blockchain - History of blockchain - Blockchain functionality- Characteristics of Blockchain -Features of Cryptography-Linking blocks using SHA - Consensus with- out identity using a blockchain - Difference of blockchain with database - Types of Cryptography Algorithms - Block structure - Symmetric Cryptogrphy- Asymmetric Cryptogrphy - Creating blockchain - Introduction to Smart Contracts - Digital signature in blockchain- Sample architecture- Tokens - Hash Pointers - Types of Blockchain - Asset ownership in blockchain - Overview of blocks, Block attributes - Transferring an asset - Applications of Blockchain.

Total Hours: 16

REFERENCE

1. Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World, 2016.

WEB REFERENCES

1. https://onlinecourses.nptel.ac.in/noc22_cs44/
2. https://www.coursera.org/specializations/blockchain

20MEI001 PROGRAMMABLE LOGIC CONTROL (PLC) 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline the basic components of Programmable logic controllers.
CO2:	Describe the hardware modules in PLC and its functioning.
CO3:	Establish communication between Hardwares and Software.

S.No	Topics	Duration (Hours)
	Theory	
1	Basics of PLC	1
2	PLC Blocks & functions	2
3	Input & Output modules	2
4	Input & Output devices	2
5	PLC Selection criteria	2
6	Hardware aspects of PLC (Only Digital Inputs & Output Devices)	2
7	Software aspects (Ladder Programming using Latching, Memory, Interlocks, Timers, Counters,comparators, move instructions) of PLC	2
	Practical	
8	Industrial Exercises	3

Total Hours: 16

20MEI002 INTRODUCTION TO INJECTION MOULDING PROCESS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline various types of molding process.
CO2:	Differentiate between Thermo and Thermo set plastics.
CO3:	Express the quality problems associated with Injection molding.

S.No	Topics	Duration (Hours)
1	**Types of molding process** Injection molding / compression molding/extrusion/blow molding	3
2	**Types of thermo plastic materials** Amorphous / crystal	3
3	**Molding machine functions** Clamping / injection /open close/ejection /melting	3
4	**Process technics in thermo plastics/thermo set** Pressure / speed / time	3
5	**Process faults and trouble shooting in thermo plastics** All quality related problem	4

Total Hours: 16

20MEI003 **GEOMETRIC DIMENSIONING & TOLERANCING** **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Summarize fundamentals of dimensioning.
CO2:	Demonstrate elements of measurement system elements and interpretation of drawing.
CO3:	Contrast the angles of projections and types of fits and tolerances.

S.No	Topics	Duration (Hours)
1	Dimensioning - General Dimensioning, Geometrical Dimensioning, Surface Texture Standards	1
2	Terminologies- Maximum Material Condition (MMC), Least Material Condition (LMC), Tolerance, Allowance, Basic Dimension, etc	2
3	Types of Tolerances- Form, Profile, Orientation, Location & Run-out	1
4	Measurement System and its Elements	1
5	Feature Control Frame	1
6	Reading and Interpretation of Drawings with respect to GD&T	2
7	Anatomy of a Drawing	1
8	Title block, Scales and BOM	1
9	Angles of projections – First and Third angle projections, Orthographic Projections	1
10	Limits, Fits & Tolerances, Type of Fits, Standards	2
11	Hole Based System, Shaft Based System, Specifying Fits in Technical Drawing	2

Total Hours: 15

20MEI004 ADVANCED CAST IRONS AND FOUNDRY MANAGEMENT 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline casting process.
CO2:	Demonstrate the need of automation and modernization of foundry Processes.
CO3:	Apply concepts of IOT in casting process.

S.No	Topics	Duration (Hours)
1	**SYSTEMATIC DEVELOPMENT OF CASTINGS:** Understanding casting drawings - review of technical requirements, costing aspects, process design and control - gating and risering design through simulation techniques - validation of process and casting quality.	4
2	**CAST IRONS FOR AUTOMOTIVE AND HYDRAULIC VALVES APPLICATIONS:** Manufacturing of cast irons - material standards - design requirements - raw material selection - process design - gating system design - process controls and testing requirements as per standards.	3
3	**SPECIAL CAST IRONS:** Austempered Ductile Iron (ADI): International standards - different types and properties - production process - austempering heat treatment process - applications - Compacted Graphite Iron (CGI): international standards - properties - production process, applications - casting suitable for sub-zero applications: design requirements - material selection - microstructure and mechanical property requirements - process design, process controls and test requirements.	4
4	**AUTOMATION AND MODERNIZATION OF FOUNDRY PROCESSES:** Advanced foundry processes and casting inspection techniques application of IoT - Foundry 4.0: need, concepts & benefits - challenges in foundry industry - special moulding techniques: shell moulding, last-wax process, lost-foam process, vacuum moulding process, foundry waste management - waste disposal and waste recycling methods.	4

Total Hours: 15

20MEI005 HEAT TREATMENT OF STEEL CASTINGS 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Summarize fundamentals of heat treatment and microstructure studies.
CO2:	Contrast the different heat processes and their advancements.
CO3:	Describe Heat treatment equipment maintenance and heat treatment standards.

S.No	Topics	Duration (Hours)
1	**Basics Heat Treatment of steels/Castings** Classification of steel and need of Heat treatment process. Basics of Heat Treatment Principles - Key Process parameters Rate of Heating, Soaking, and Rate of cooling.	3
2	**Micro structure study** Micro Structure of different steel grades. Effect of different alloying elements and its impact on heat treatment process.	2
3	**Different Heat Treatment Process** Full Annealing, Stress Relief Annealing, Process Annealing, Normalizing, Hardening, Tempering, Different Mechanism of heat removal in hardening process, Mass effect, Harden ability of steel parts. Solution annealing	3
4	**Special Heat Treatment Process** Carburizing, Heat Treatment after carburizing, Cyaniding and Carbonitriding, Nitriding, Induction Hardening, Flame Hardening,	2
5	**Heat Treatment Equipment Maintenance** Different parts and segments of heat treatment equipment. Need of Procedures, Equipment Calibration, Heat Treatment Process Validation, Documentation and Reading of Heat Treatment Graphs.	3
6	**Heat Treatment Standards** Relevant Heat Treatment Requirements and specification, ASTM Standard, EN Standard Requirements. Dos and Don'ts of Heat treatment, Heat Treatment Failures and its Control Measures.	2

Total Hours: 15

20MEI006 **INDUSTRIAL AUTOMATION** **1 0 0 1**

COURSE OUTCOMES:

On successful completion of the course, students will be able to :

CO1:	Select & identify suitable automation hardware for the given application.
CO2:	Describe & explain potential areas of automation.
CO3:	Differentiate various control aspects of automation.
CO4:	Demonstrate the self-learning capability of Industrial Automation.
CO5:	Candidates would understand the concepts of Basic Components of Automation, Hardware / Software classification of Automation concepts like - PLC, SCADA and MMI/HMI

S.No	Topics	Duration (Hours)
1	Automation in Production Systems	2
2	Automation Principles and Strategies	2
3	Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations	2
4	Reasons for Automation and its need	2
5	Overview of Manufacturing	2
6	Automation and Control Technologies	2
7	Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Modeling and Simulation for Plant Automation	3

Total Hours: 15

20MEI007 **INDUSTRIAL SAFETY** **1 0 0 1**

COURSE OUTCOMES:

On successful completion of the course, students will be able to :

CO1:	Apply standard safety procedures in an industrial environment.
CO2:	Work place ergnomics and practices
CO3:	How to use PPE and its role
CO4:	How to conduct JSA (Job safety Analysis)
CO5:	Preparation and execution of work permit system

S.No	Topics	Duration (Hours)
1	Introduction to industry practices	1
2	Work place ergonomics	1
3	Fire safety & Mock drill	1
4	Equipment safety Confined space entry	2
5	Personal protective equipment (PPE)	2
6	Job Safety Analysis	2
7	Environment Safety and Analysis	2
8	Fall prevention	2
9	Work permit system and its need	2

Total Hours: 15

20MEI008 METAL ADDITIVE MANUFACTURING 1 0 0 1

COURSE OUTCOMES:

On successful completion of the course, students will be able to :

CO1:	Understand application potential of Additive Manufacturing in Industrial context.
CO2:	Demonstration of Industrial Metal AM based solution for development of Aerospace and Automotive Parts.
CO3:	Understand in depth about laser powder bed fusion, it's characteristics and manufacturing outcomes.
CO4:	Virtual walkthrough of Advance Technology Centre of Wipro3D, Peenya Industrial Area, Bangalore.

S.No	Topic
1	AM Processes and Materials- Vat Polymerization, Extrusion, Powder Bed Fusion and Binder Jetting. AM Materials of Photopolymers, Plastics and Composites.
2	Basics of Metal Additive Manufacturing - Metal Powder Bed Fusion, Electron Beam Melting, Metal Binder Jetting and Directed Energy Deposition.
3	Process Physics for Laser Powder Bed Fusion - Brief overview of the build environment, Basics of Input data preparation, Laser-particle Interaction, Concepts of Energy Density and Process Window.
4	Materials for LPBF - Material characteristics for feedstock, Factors governing selection of material, microstructure and mechanical properties of LPBF material used in strategic and core sectors.
5	Additive Engineering - Overview of the Additive Engineering framework. Design for Additive Manufacturing, Value addition through introduction of Metal AM in part development cycle, Part Consolidation, Light Weighting, Extended Design Freedom, Distributed Manufacturing and Mass Customization.
6	Topology Optimization - Simulation driven design, Concept of Design Space, Load cases & Constraints and Industrial Case Study of Upright Knuckle/Bracket (E-vehicle component).
7	Part Building on Industry Grade LPBF System - Laser exposure parameters, exposure strategy, process conditions, and selection of substrate. Build file generation for LPBF, Powder recovery using Integrated Process Chain Management.
8	Post processing for metal AM - Stock addition for post process machining, considerations for part orientation & part positioning and design of support structures for heat dissipation. Explanation with industrial examples. Considerations for stress relieving and separation of substrate and part. Surface treatment techniques - abrasive flow machining, MMP, tumbling, shot blasting etc.
9	Elements of Industry Grade LPBF System (EOS M290) - Process chamber, laser optics, recirculating filter system, cooling system for laser, in-situ process monitoring using optical imaging.

Total Hours: 16

20MEI009 NON-DESTRUCTIVE TESTING 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1: Outline the testing procedures of Liquid Penetrant Testing.

CO2: Summarise the concept, principle and testing procedures of Magnetic Particle Testing

CO3: Demonstrate the concept of Ultrasonic wave and its application for various inspection methods.

CO4: Illustrate the concepts and principles of Radiography

S.No	Topics	Duration (Hours)
1	**Liquid Penetrant Testing** Introduction -Principle of liquid penetrant Testing -Methods of Pre -cleaning - Properties of Penetrant -Types of Penetrant -Methods of Penetrant ap plication - Methods for removal of excess Penetrant -Methods for drying -Properties of developers -Types of developers -Methods for developer application -Inspection requirements -Post cleaning -Usage of black light for inspection -Familiarization of variou s Penetrant systems -Codes, standards and specification -Evaluation of Defects -Preparation of test reports.	4
2	**Magnetic Particle Testing** Introduction - Theory on Magnetism - Magnetic Field - Permanent magnets and electromagnets - Hysteresis Loop - Diamagnetic, paramagnetic and ferromagnetic materials - Circular and longitudinal magnetization - Principle of magnetic Particle Testing - Familiarization of common magnetic particle equipments - Detecting medium - Demagnetization - Usage of black light for i nspection - Codes, standards and specification - Evaluation of Defects - Preparation of test reports.	4
3	**Ultrasonic Testing** Introduction - Theory on Sound - Wave theory - Types of sound waves - Velocity of sound in material - Amplitude of sound - Modes of sound waves - Familiarization of common ultrasonic equipments - Familiarization of ultrasonic testing probes - Familiarization of Calibration Standards - Training on A Scan Equipment - Production of ultrasound - Types of probes - Features of probes - Profile of sound (Near field, far field and Dead Zone) - Selection of probe diameter - Selection of probe frequency – Sensitivity.	4
4	**Radiographic Testing** Introduction - Structure of Atom - Production of X -ray and Gamma Ray - Radiation Safety and work p ermit system - Interaction of radiation with matter - Radiation detection and measurement - Regulations on use of radiography sources - Elements of industrial radiography - Geometrical principles in image quality - Selection of radiation source - Control o f scattered radiation - Selection of radiography films - Radiographic Techniques - Radiography of castings - Radiography of tanks and vessels - Calculation of exposure time - Special Radiographic Techniques - Codes, standards and specification - Radiographic Test Film Interpretation - Preparation of test reports.	4

Offered By: M/s Shri Sai NDT, Pondicherry

20MEI010 HVAC BUILDING LOAD CALCULATIONS PSYCHROMETRY **1 0 0 1**

COURSE OUTCOMES

On successful completion of the course, students will be able to

Demonstrate various Refrigeration Cycles.

Estimate the Cooling Load of Air - Conditioning Systems.

Examine Air-Conditioning Processes with the help of Psychrometric Chart.

S.No.	Topic	Duration (Hours)
1.	Air Distribution: Types of supply air outlets, Room Air distribution.	2
2.	Mechanism of flow through Inlets and outlets.	2
3.	Selection and Location of outlets.	1
4.	General considerations. Distribution patterns of outlets.	1
5.	Ducts Definition and types – Materials for ducts and its specification, friction loss in ducts.	2
6.	Duct design procedure, Duct construction, Air duct designs.	7

Total Periods: 15 Hours

Offered By: M/s Sigma Solutions, Coimbatore

20MEI011 HVAC AIR DISTRIBUTION SYSTEM 1 0 0 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

Select effective room air distribution systems and associated flow machines and control systems.

Study of various outlets and its mechanism of flow through outlets

Construct and Design of air duct systems

S.No.	Topic	Duration (Hours)
1.	Air Distribution: Types of supply air outlets, Room Air distribution.	2
2.	Mechanism of flow through Inlets and outlets.	2
3.	Selection and Location of outlets.	1
4.	General considerations. Distribution patterns of outlets.	1
5.	Ducts Definition and types – Materials for ducts and its specification, friction loss in ducts.	2
6.	Duct design procedure, Duct construction, Air duct designs.	7

Total Periods: 15 Hours

Offered By: M/s Sigma Solutions, Coimbatore

20MEI012 **CONTROL AUTOMATION** **1 0 0 1**

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO1	Outline the basics of Industrial Automation
CO2	Describe the communication protocol and understand the concepts of ladder diagrams
CO3	Demonstrate the communication protocol between PLC and PC

S.No	Topics	Duration (Hours)
	Theory	
1.	Introduction to Industrial Automation	1
2.	Types & Tools of automation	2
3.	Roles of Relays in Automation	1
4.	Introduction to communication protocol	1
5.	Industrial Communication protocols Modbus protocol	1
6.	Introduction to Ladder Diagram	1
7.	Concepts of Ladder Diagram • Logic Gates implementation • Series & parallel connections • Timer	2
8.	Communication Protocol between PLC and PC	1
9.	Simulating application problems in software	2
	Practical	
10.	Real time application problems	2
11.	**Hands on** PLC Hardware	2

Total Periods : 16

Offered By: M/s Axis Global automation, Coimbatore

20MEI013 **TOOL DESIGN** **1 0 0 1**

COURSE OUTCOMES:

On successful completion of the course, students will be able to

CO1	Outline the basics of Tool design
CO2	Apply the concepts of DFM in jigs and fixtures and understand the inspection techniques
CO3	Assign the tolerance in manufacturing application
CO4	Demonstrate the drawing knowledge and application of GD&T

S.No	Topics	Duration (Hours)
	Theory	
1.	Introduction – application & functions	2
2.	Design & manufacturing techniques of jigs and Fixtures - Inspection Techniques	4
3.	Tolerance: Tolerance application in manufacturing in tooling and other areas.	4
4.	GAUGES- Inspection technique	3
	Practical	
5.	CAD Software : Design Drawing with Application of GD&T	4

Total Hours: 15

Offered By: M/s Mechtech Engineering centre, Coimbatore

20NTI001 PHYSICAL CHARACTERIZATION AND APPLICATIONS OF NANOMATERIALS 1 0 0 1

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1:	Define the principles behind various surface characterization techniques like Atomic Force Microscopy, Scanning Electron Microscopy and X Ray diffraction and correlate the results for analyzing the properties of nanomaterials
CO2:	Perform suitable experimentations deduced from the results of the analytical methods

INTRODUCTION AND SYNTHESIS **5**

History of Nanomaterials - Definition of a Nanosystem - Dimensionality and size dependent phenomena - Time and length scale in structures - Synthesis of Nanomaterials - Nucleation growth - Aggregation of nanoparticles - Top-down and Bottom-up approach

METHODS AND TECHNIQUES **5**

Atomic Force Microscopy - Contact mode - Non contact mode - Tapping mode - Scanning Electron Microscopy-Types of SEM - FE SEM - Environmental SEM - Transmission SEM - X-Ray Diffraction -Types of XRD - Single crystal XRD - Powder XRD - Analysis of liquid samples - SAXS and WAXS

APPLICATIONS **5**

Surface analysis of thin film biosensors - Atom by Atom manipulation for fabricating MEMS and NEMS- Analysis of structures of Silicon Chips -Analysis of scaffolding materials behavior- Identification of amorphous and crystalline behaviors of organic and inorganic drug delivery systems- Calculation of elemental composition of nanocomposites- Hands on training - Data interpretation

Total Periods: 15

TEXT BOOKS

1. Rao C.N.R, Muller.A and Cheetham A.K, "The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Volume-I and II", John Wiley & Sons Inc, 2005
2. Wang Z.L, "Characterization of Nanophase Materials", Wiley Interscience International, 2001

REFERENCE BOOKS

1. Shard A, Hodoroaba V-D, Unger W, "Characterization of Nanoparticles", Elsevier, 2019
2. Sanders W.C, Atomic Force Microscopy, "Fundamental Concepts and Laboratory Investigations", CRC press, 2019
3. Hamid U.A, "A Beginners' Guide to Scanning Electron Microscopy", Springer, 2018
4. Seeck O.H, Murphy B.M, "X-Ray Diffraction; Modern Experimental Techniques", Pan Stanford publications, 2015

NPTEL MATERIAL

1. Introduction to Nanotechnology, IIT Delhi, https://nptel.ac.in/courses/118/102/118102003/
2. Fundamentals of X ray Diffraction by Department of Materials and Metallurgical Engineering,IIT Madras, https://nptel.ac.in/courses/113/106/113106069/
3. Fundamentals of Optical and Electron microscopy by Department of Materials and Metallurgical Engineering, IIT Madras, https://nptel.ac.in/courses/113/106/113106064/

WEB RESOURCES

1. Introduction to AFM, MIT Openware, https://ocw.mit.edu/courses/biological-engineering/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/tools/tutorial-1/

CASE STUDIES

1. Identification of thickness of polymeric thin films by AFM for usage in sensors.
2. Porosity distribution analysis in Mesoporous silica materials used in cosmetic industries.
3. Identification of crystallite size of Quantum dots for Bioimaging techniques.

20NTI002 OPTICAL CHARACTERIZATION AND APPLICATIONS OF NANOMATERIALS 1 0 0 1

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1:	Define the fundamental working principles of spectroscopy tools such as Fourier Transform Infrared, UV-Visible and fluorescence.
CO2:	Illustrate the instrumentation components of various spectrometers and particle size analyzer.

INTRODUCTION AND SYNTHESIS **5**

History of Nanomaterials - Definition of a Nanosystem - Dimensionality and size dependent phenomena - Time and length scale in structures - Synthesis of Nanomaterials - Nucleation growth - Aggregation of nanoparticles - Top-down and Bottom-up approach

METHODS AND TECHNIQUES **5**

Principles and instrumentations - Fourier Transform Infrared Spectroscopy - UV-visible Spectroscopy - Particle size analysis - Dynamic light scattering - Dispersion, Size and distribution of particles - Brownian motion - Electrical double layer - Surface charges and Zeta potential - Fluorescence spectroscopy

APPLICATIONS **5**

Industrial applications - Spectroscopic chemical identification of nanocomposites - Forensics industries - Identification of controlled substances - Research on nanocolloid-electrolyte interactions - Electronic circuits dopant analysis -Characterization of 2D photonic crystals- Luminescence properties of quantum dots, nanotubes, new phosphors and LED materials.

Total Hours: 15

TEXT BOOKS

1. Murty B. S, Shankar P, Raj B, Rath B. B and Murday J, "Textbook of Nanoscience and Nanotechnology", Springer, 2013.
2. Vollath D,"Nanomaterials: An Introduction to Synthesis, Properties and Applications", 2nd Edition, Wiley, 2013.
3. Sidney Perkowitz, "Optical Characterization of Semiconductors, Volume 14 1st Edition", Academic Press, 2012.
4. Dalip Singh Verma, Latif Ullah Khan, Shalendra Kumar, Sher Bahadar Khan, Surender Kumar Sharma, "Handbook of Materials Characterization", Springer, 2018.

REFERENCES & JOURNAL ARTICLES

1. S Zhang, L. Li, Ashok Kumar, "Materials Characterization Techniques", CRC Press, 2008
2. Valsangkar A. J., "Principles, methods and applications of particle size analysis", Can. Geotech. J., 29, 1006, 1992
3. Stetefeld J., McKenna S. A., Patel T. R., "Dynamic light scattering: a practical guide and applications in biomedical sciences", Biophysical Rev. 8, 409-427, 2016
4. Barbara H. Stuart, "Infrared Spectroscopy: Fundamentals and Applications", Wiley, 2004.
5. Douglas A. SkoogStanley R. CrouchF. James Holler, "Principles of Instrumental Analysis", 6th Edition, Cengage, 2014
6. Lakowicz Joseph R, "Principles of Fluorescence Spectroscopy", 3rd edition, Springer, 2006.

WEB REFERENCES

1. NPTEL : Introduction to Nanotechnology https://nptel.ac.in/courses/118/104/118104008/
2. NPTEL: Basics of Fluorescence Spectroscopy, https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-cy01/
3. NPTEL: Introduction to Spectroscopy, https://nptel.ac.in/courses/104/106/104106122/
4. MIT OpenCourseWare: Fundamentals of Spectroscopy, https://ocw.mit.edu/courses/chemistry/5-35-introduction-to-experimental-chemistry-fall-2012/labs/MIT5_35F12_Mod1_Background.pdf

CASE SUDIES

1. Identification of cross linking in thin films by using FTIR.
2. Analysis of Surface Plasmon Resonance mediated detection of heavy metals in aqueous systems.
3. Identification of metal enhanced fluorescence in organic dyes using fluorescence spectroscopy.

20NTI003 ELECTROCHEMICAL CHARACTERIZATION AND APPLICATIONS OF NANOMATERIALS 1 0 0 1

COURSE OUTCOMES

On completion of this course, the students will be able to

CO1:	Define the theoretical principles behind various electrochemical characterization techniques such as Impedance spectroscopy, Polarization, electrical, surface, etc.
CO2:	Apply the suitable characterization technique to analyze nanoparticles and correlate the theoretical principles behind analytical data
CO3:	Illustrate the methodology of various analyses used and compare that with the other types of characterization techniques

INTRODUCTION AND SYNTHESIS 5

History of Nanomaterials - Definition of a Nanosystem - Dimensionality and size dependent phenomena - Time and length scale in structures - Synthesis of Nanomaterials - Nucleation growth - Aggregation of nanoparticles - Top-down and Bottom-up approach

METHODS & TECHNIQUES 5

Fundamental aspects of electrode reactions -Experimental parameters - Preparation of modified electrode - Cyclic Voltammary and Differential Pulse Voltammetry - Electrochemical Impedance spectroscopy - Faradaic and Non Faradaic reactions - I/V characterization - Hands on Training

APPLICATIONS 5

Types of Applications - Real-time analyte sensing - Corrosion monitoring and inhibition - Industrial applications - Supercapacitor, Solar cell and Battery applications - Electric vehicle components - Hands on Training - Data interpretation

Total Periods: 15

TEXT BOOKS

1. Murty B. S, Shankar P, Raj B, Rath B. B andMurday J, "Textbook of Nanoscience and Nanotechnology", Springer, 2013.
2. Vollath D,"Nanomaterials: An Introduction to Synthesis, Properties and Applications", 2nd Edition, Wiley, 2013.
3. Bagotsky V. S, "Fundamentals of Electrochemistry", 2nd Edition, John Wiley & Sons, Inc., 2006.

REFERENCE BOOKS

1. Aliofkhazraei, Mahmood, Makhlouf and Hamdy A.S, "Handbook of Nanoelectrochemistry", Springer International Publishing, 2016.
2. Wang J, "Analytical Electrochemistry", 3rd Edition, John Wiley & Sons, Inc,, 2006.
3. Rahman M. M and Asiri A. M, "Electrochemical Sensor Technology", IntechOpen, 2017.
4. Ni J and Lu L, "Functional Materials for Next-Generation Rechargeable Batteries", World Scientific Publishing, 2021.
5. Noel M and Vasu K. I, "Cyclic Voltammetry and the Frontiers of Electrochemistry", Oxford & IBH Publishing Company, 1990.
6. Bard A. J and FaulknerL. R, "Electrochemical Methods: Fundamentals and Applications", 2nd Edition, John Wiley & Sons, Inc., 2001.

WEB REFERENCES

1. NPTEL : Introduction to Nanotechnology https://nptel.ac.in/courses/118/104/118104008/
2. Fundamentals of Electrochemical Techniques, Prof. J. R. Mudakavi, Department of Chemical Engineering, IISc, Bengaluru, https://www.youtube.com/watch?v=l2ENx_Y0dNU
3. ElectrochemicalMethods, https://nptel.ac.in/content/storage2/courses/103108100/module6/module6.pdf
4. Selection of Nanomaterials for Energy Harvesting and Storage Applications, Prof. Kaushik Pal, IIT Roorkee, https://onlinecourses.nptel.ac.in/noc20_me83/preview
5. Electrochemical Energy Storage, Prof. S. B. Majumder, IIT KGP, https://onlinecourses.nptel.ac.in/noc21_mm34/preview

CASE STUDIES

1. Case studies on analyte of interest sensing in several industrial effluents
2. Case studies on corrosion inhibition on various objects
3. Case studies on lab scale fabrication of solar cells

20RAI001 EXPLORING ROS BASICS AND MODELLING

Course Description:

This Course provides an intuitive understanding on ROS framework which will help the learners to leverage their knowledge in Robot Software Development. This course has been designed for undergrads for their academic purposes and to realize virtual robot development and simulation.

Course Objective:

To enhance and uplift the skills in Robot Software Development using Robot Operating System.

Course Plan:

Module 1: BASICS & INTRODUCTION TO ROS

- Introduction to ROS (Robot Operating System)
- Linux Environment Setup
- Basic Linux Commands & Python
- Installing ROS, Tools & Plugins related to ROS
- Creating a ROS Package & Nodes
- Understanding ROS Topics
- Concept of Publisher/Subscriber Python + ROS Launch creation
- Procedure for ROS bag recording and playback

Module 2: 3D DESIGNING & MODELLING, CAD TO URDF CONVERSION

- Installing and Introduction to CAD & Designing softwares
- Make simple 2D Cad drawings & 3D models
- Fusion2URDF Installation & Debugging

Total Hours: 15

References Text Books:

- Introduction to Mobile Robotics, Roland Seigwart
- Probabilistic Robotics, Wolfram Burgard, Sebastian Thrun and Dieter Fox

20RAI002 ROS TOOLS, MAPPING AND NAVIGATION

Course Description: This Course provides an intuitive understanding on various ROS Tools and it's Hardware and software integration

Course Objective:

To enhance and uplift the skills in ROS Tools and Simulations

Course Plan:

Module 1: ROS TOOLS - GAZEBO, RVIZ & RQT

- Cleaning FUSION2URDF package & Setting Parameters for Teleoperation
- Introduction to Blender and using it to model DAE files for making Gazebo World
- Introduction to RViz and using RQT graph
- Exploring & Implementing gazebo plugins

Module 2: SIMULATION, ROS Hardware Integration, MAPPING & NAVIGATION

- Demo of Tortoise Bot and understanding navigation package file systems
- Setting up ROS and Hardware Communication
- Introduction and Implementation of SLAM on Self-designed robot and TortoiseBot
- Introduction, Implementation & Dynamic Tuning of Navigation Stack on Self-designed robot and TortoiseBot

Total Hours: 15

20RAI003 INDUSTRIAL ELECTRIC PANEL DESIGN

Objective:

Basic knowledge to design and built industrial control panel in an automation industry.

Course Outcome: Understanding the basics design knowledge of a control panel and User Interface of DRAFTSIGHT (CAD Software).

Course Content

1: Electrical Control Design - 5 HOURS

- Selection and sizing of MCB, MCCB, SMPS, DISCONNECTOR SWITCH etc,
- Understanding the basics of RELAY, CONTACTOR, SAFETY RELAY etc,
- Selection of motor drivers, VFD's,
- Selection of Programmable Logic Controller (PLC), Human Machine Interface (HMI).

2: Electrical Control Cad Design - DRAFTSIGHT - 10 HOURS

- Basic of electrical symbols and electrical CAD design,
- Sheet format & Layout design,
- AC & DC Control wiring,
- Safety Concept of designing a project,
- Earthing and cabling of panels,
- Control Panel sizing & Rating selection.

Total Hours: 15

20RAI004 MOTION CONTROL

Objective:

Basic knowledge to design and built systems using motion control systems

Course Outcome:

Understanding the basics on Motion Control Systems using Matlab Software

Course Content:

1. Single Axis Systems
2. Multi Axis Systems and its applications
3. Linear Positioning
4. Simple and Modular System Positioning
5. Rotary Indexing
6. Gantry Systems

Total Hours: 15

ENLIGHTENMENT THROUGH EDUCATION SREC

20RAI005 AUTOMATION USING PLC, SCADA AND HMI

Objective:

Basic knowledge in Automation using major key in the technology and industrial sector.

Course Outcome:

Understand the fundamentals of automation and acquire knowledge on controlling and Monitoring system using PLC, SCADA and HMI.

Course Content:

Module 1: Introduction to Industrial Automation and Controlling Systems

Types of automation -Current scenario of Automation -Tools of automation -Introduction to PLC -Programming languages in PLC -Introduction to Ladder Diagram -Concepts of Ladder Diagram -Real time application problems - Introduction to PLC software -Simulating application problems in software -Introduction to SCADA -Introduction to Role of SCADA in chemical industries -Basic tag creation in SCADA Digital valves ON & OFF control

Module 2: HMI Software and Communication Protocols.

Analog input tags -Analog values monitoring and control - Screen development using tags - Basic scripting operations - Looping operations - Digital and Analog alarms in Industries - Introduction to HMI - Configurations in HMI Software Input functions in HMI software - Industrial Screen development in HMI - Communication protocols - Hands on PLC Hardware Description - Hands on HMI Hardware Description - Career opportunities in core field

Total Hours: 15

20RAI006 ROBOTIC SIMULATION USING MOTO SIM SOFTWARE

Objective:

Basic knowledge to design and simulate a Robotic cell.

Course Outcome:

Understanding the Offline programming, 3D simulation and Virtual Robot Control.

Course Content:

Module 1: Introduction to Industrial Robotics.

Types of Industrial Robotics -Anatomy of Industrial Robotics -Application of Industrial Robotics - Introduction to Motosim EG -Adding Robot from Library -Adding End Effecter to Robot - Introduction to Interpolation - Different types of Interpolation -Teaching for 2D object using different types of Interpolation - Applications on 2D object teaching

Module 2: Application development of 3D object teaching.

Teaching for 3D object - Introduction to Co-ordinate system - Different types of Coordinate system Working with Timers - Working with Jump - Working with If Condition - Industrial application Development - Conveyer Tracking Method

Total Hours: 15

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

(MANDATORY COURSE)

ENLIGHTENMENT THROUGH EDUCATION
SREC

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

(MANDATORY COURSE)

COURSE OBJECTIVES

1. Development of a holistic perspective based on self-exploration about them selves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

In an effort to bring in the value aspect, AICTE has taken the initiative to include (Universal Human Values) UHV in the model curriculum for professional education in 2018. In this regard, inputs on human values are being imparted to all the students admitted in B.E./ B.Tech during Students Induction Programme (SIP) conducted for three weeks. In continuation to this, Universal Human Values and Professional Ethics are also being taught in three consecutive semesters as follows.

Semester	Course Code	Course Title	No of Contact Hours
I	20HS205	UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART I	15
II	20HS206	UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART II	15
III	20HS207	UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III	15

This course is conducted through discussion in small groups (20 students) each mentored by a faculty member. Lecture hours are to be used for interactive discussion placing the proposals about the topics and motivate the students to reflect, explore and verify them. For every module, 75 % attendance is mandatory and a minimum of 15 marks is mandatory for the successful completion of the course.

20HS205

SEMESTER - I

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART 1

(Common to all B.E. / B.Tech Programmes)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Identify the basic requirements for human aspiration.	PO6, PO7, PO8, PO12
CO2:	Develop a holistic perspective based on self-exploration about the self, family and society.	PO6, PO7, PO8, PO12

BASIC HUMAN ASPIRATIONS AND UNDERSTANDING HARMONY IN THE HUMAN BEING 15

Need for Value Education - Basic requirements for fulfilment of aspirations - Self-Exploration - Natural Acceptance - Experiential Validation - Continuous Happiness and Prosperity - Right understanding, Relationship and Physical Facility.

Understanding Harmony in the Human Being - Co-existence of the self and body - Understanding the needs - characteristics - activities of Self ('I') and 'Body' - happiness and physical facility - Understanding Harmony in the Family and Society- Understanding values in human-human relationship - nine universal values in relationships - trust - respect - affection - care - guidance - reverence - glory - gratitude - love - Difference between intention and competence - Harmony in the society - Extending relationship from family to society.

Total Hours: 15

TEXT BOOKS

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition,2014.
2. R. S. Naagarazan "A Textbook on Professional Ethics and Human Values" New Age International (P) Limited, Publishers, 1st Edition,2006.

REFERENCES

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values",PHI Learning Pvt Ltd, 2nd Edition,2009.
2. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics" Excel Books, New Delhi, 1st Edition, 2010.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.
4. A.N. Tripathy, "Human Values", New Age International Publishers, 3rd Edition, 2019.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS206

SEMESTER - II

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART II

(Common to all B.E. / B.Tech Programmes)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Develop a holistic perspective of harmony at all levels of existence.	PO6, PO7, PO8, PO12
CO2:	Summarize various social and environmental problems to act ethically.	PO6, PO7, PO8, PO12

HARMONY IN NATURE AND ENVIRONMENTAL CONCERN 15

Four orders of nature - interconnectedness and mutual fulfilment - Holistic perception of harmony at all levels of existence - Human being as cause of imbalance in nature.

Basic Environmental Issues - pollution, depletion of resources and role of technology - Sustainable Development - Global Environmental Issues - International Initiatives on Environmental Issues - Environmental Impact Assessment - Engineer's Role in Environment Protection - Environmental Engineering - Green Design - Principles of Green Design - Environmentally Conscious Manufacture - Basic Approaches for Resolving Environmental problems - Natural acceptance of human values - Holistic perception of harmony at all levels of existence.

Total Hours: 15

TEXT BOOKS

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition,2014.
2. R. S. Naagarazan "A Textbook on Professional Ethics and Human Values" New Age International (P) Limited, Publishers, 1stEdition, 2006.

REFERENCES

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values",PHI Learning Pvt Ltd, 2nd Edition,2009.
2. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics" Excel Books, New Delhi, 1st Edition, 2010.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.
4. A.N. Tripathy, "Human Values", New Age International Publishers, 3rd Edition, 2019.

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1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS207

SEMESTER - III

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III

(Common to MECH, EEE, EIE and RA)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline engineering education and responsibilities of Engineers.	PO6, PO7, PO8, PO12
CO2:	Relate sound morals and ethical values scrupulously to prove as good citizens.	PO6, PO7, PO8, PO12

ENGINEERING ETHICS AND GLOBAL ISSUES 15

Definitiveness of Ethical Human Conduct - Competence in professional ethics - Role and Responsibilities of Engineers - Safety and Risk - Underestimation and Overestimation of Risk - Designing for Safety - Professional societies and their codes of ethics - Constraints in engineering - Engineering as Experimentation - Similarities to standard Experiments - Learning from the past - Knowledge gained - Framing the problem.

Globalisation: Benefits - Transfer of Technology - Relative Values - International Rights - Promoting Morally Justifiable Measures - Business Process Outsourcing.

Computer Ethics: Computer Crimes - Categories - Commandments of Computer Ethics - Ethical Principles for SoftwareMobile Etiquette Guidelines - Ethical Hackers.

Total Hours: 15

TEXT BOOKS

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition,2014.
2. R. S. Naagarazan "A Textbook on Professional Ethics and Human Values" New Age International (P) Limited, Publishers, 1stEdition, 2006.

REFERENCES

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values",PHI Learning Pvt Ltd, 2st Edition,2009.
2. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics" Excel Books, New Delhi, 1st Edition, 2010.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.
4. A.N. Tripathy, "Human Values", New Age International Publishers, 3rd Edition, 2019.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS207

SEMESTER - III

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III (ECE)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline engineering education and responsibilities of Engineers.	PO6, PO7, PO8, PO12
CO2:	Relate sound morals and ethical values scrupulously to prove as good citizens.	PO6, PO7, PO8, PO12

ENGINEERING ETHICS AND GLOBAL ISSUES **15**

Definitiveness of Ethical Human Conduct - Competence in professional ethics - Role and Responsibilities of Engineers - Safety and Risk - Underestimation and Overestimation of Risk - Designing for Safety - Professional societies and their codes of ethics - Constraints in engineering - Engineering as Experimentation - Similarities to standard Experiments - Learning from the past - Knowledge gained - Framing the problem.

Globalisation: Benefits - Transfer of Technology - Relative Values - International Rights - Promoting Morally Justifiable Measures - Business Process Outsourcing.

Computer Ethics: Computer Crimes - Categories - Commandments of Computer Ethics - Ethical Principles for Software Mobile Etiquette Guidelines - Ethical Hackers - Ethical issues in IoT.

Total Hours: 15

TEXT BOOKS

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition,2014.
2. R. S. Naagarazan "A Textbook on Professional Ethics and Human Values" New Age International (P) Limited, Publishers, 1stEdition, 2006.

REFERENCES

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values",PHI Learning Pvt Ltd, 2nd Edition,2009.
2. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics" Excel Books, New Delhi, 1st Edition, 2010.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.
4. A.N. Tripathy, "Human Values", New Age International Publishers, 3rd Edition, 2019.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS207

SEMESTER - III

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III (AERO)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline engineering education and responsibilities of Engineers.	PO6, PO7, PO8, PO12
CO2:	Relate sound morals and ethical values scrupulously to prove as good citizens.	PO6, PO7, PO8, PO12

ENGINEERING ETHICS AND GLOBAL ISSUES 15

Definitiveness of ethical human conduct - Competence in Professional ethics - Role and Responsibilities of Engineers - Safety and Risk - Underestimation and Overestimation of Risk - Designing for Safety - Professional Societies and their codes of ethics - Constraints in Engineering - Engineering as Experimentation - Similarities to Standard Experiments - Learning from the past - Knowledge gained - Framing the problem.

Globalisation: Benefits - Transfer of Technology - Relative Values - International Rights - Promoting Morally Justifiable Measures - Business Process Outsourcing.

Engineers as Managers: Engineers as Expert Witnesses and Advisors - Moral Leadership - Sample Code of Conduct -Government agencies - Resolving Employee concerns - Limits on acceptable behavior in large corporation - Ethical and legal considerations, Organizational responses to offensive behavior and harassment.

Computer Ethics: Computer Crimes - Categories - Commandments of Computer Ethics - Ethical Principles for Software Mobile Etiquette Guidelines - Ethical Hackers.

Total Hours:15

TEXT BOOKS

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition,2014.
2. R. S. Naagarazan "A Textbook on Professional Ethics and Human Values" New Age International (P) Limited, Publishers, 1st Edition, 2006.

REFERENCES

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values",PHI Learning Pvt Ltd, 2nd Edition,2009.
2. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics" Excel Books, New Delhi, 1st Edition, 2010.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.
4. A.N. Tripathy, "Human Values", New Age International Publishers, 3rd Edition, 2019.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS207

SEMESTER III

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III (CSE)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline engineering education and responsibilities of Engineers.	PO6, PO7, PO8, PO12
CO2:	Relate sound morals and ethical values scrupulously to prove as good citizens.	PO6, PO7, PO8, PO12

HUMAN VALUES AND GLOBALIZATION - ROLE AS AN ENGINEER **5**

Human Moral Values- Integrity- Commitment- Challenges in the workplace - Engineering Ethics - Engineering as a Social Experimentation - Safety, Responsibility and Rights - Global Issues and Ethical perspectives.

ETHICS IN INFORMATION TECHNOLOGY ERA **10**

Professional Codes of Ethics- Common Ethical Issues for IT users - Implementing Trustworthy computing- Freedom of Expression- Key Intellectual property issues- The Impact of IT on Healthcare- The use of online Social Networking - Cyberbullying- Cyberstalking - Encounters with sexual predators- Uploading of Inappropriate material- Educational and Business use of Virtual worlds- Industry Code of Conduct (ICT).

Total Hours:15

TEXT BOOKS

1. Tanu Shukla, Anupam Yadav, "Human Values and Professional Ethics", Cenage Learning, 1st Edition, 2017.
2. R. S. Naagarazan "A Textbook on Professional Ethics and Human Values" New Age International (P) Limited, Publishers, 1st Edition, 2006.
3. George W. Reynolds, "Ethics in Information Technology", Fifth Edition, Cengage learning, 5nd Edition, 2015.

REFERENCES

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition, 2014.
2. PSR Murthy "Indian Culture, Values and Professional Ethics" BS Publication, 1st Edition, 2014.
3. Keith W Miller, MariarosariaTaddeo, "The Ethics of Information Technologies", Rouledge, 1st Edition, 2016.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS207

SEMESTER - III

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III (IT and AI & DS)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Outline engineering education and responsibilities of Engineers.	PO6, PO7, PO8, PO12
CO2:	Relate sound morals and ethical values scrupulously to prove as good citizens.	PO6, PO7, PO8, PO12

ENGINEERING ETHICS AND GLOBAL ISSUES **15**

Need for Engineering Ethics - Role and Responsibilities of Engineers - Safety and Risk - Underestimation and Overestimation of Risk - Designing for Safety - Professional societies and their codes of ethics - Constraints in engineering - Engineering as Experimentation - Similarities to standard Experiments - Learning from the past - Knowledge gained - Framing the problem.

ETHICS OF ARTIFICIAL INTELLIGENCE

Introduction to AI Ethics - Ethical challenges in AI based systems - Responsible AI principles:Fairness, privacy, security, transparency, accountability, reliability and safety - The Responsible AI Development Lifecycle - Ethical frameworks for evaluating AI systems - use cases: TAM-DEF and DEEP-MAX scorecard

Total Hours: 15

TEXT BOOKS

1. Prof.D.R.Kiran "Professional Ethics and Human Values" McGraw Hill Education (India) Private Limited New Delhi, 2nd Edition, 2014.
2. David Carmona, "The AI Organization", O'Reilly Media, Inc., 1st Edition, 2019.

REFERENCES

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values",PHI Learning Pvt Ltd, 2nd Edition,2009.
2. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics" Excel Books, New Delhi, 1st Edition, 2010.
3. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.
4. A.N. Tripathy, "Human Values", New Age International Publishers, 3rd Edition, 2019.
5. Mark Coeckelbergh, "AI Ethics", MIT Press Essential Knowledge series, 1st Edition, 2020

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. https://nptel.ac.in/courses/120/108/120108004/
3. https://nptel.ac.in/courses/109/104/109104068/

20HS207

SEMESTER - III

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS - PART III (CIVIL)

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1:	Outline engineering education and responsibilities of Engineers.	PO6, PO7, PO8, PO12
CO2:	Relate sound morals and ethical values scrupulously to prove as good citizens.	PO6, PO7, PO8, PO12

ENGINEERING ETHICS AND HUMAN VALUES 15

Introduction to Ethics; Engineering Ethics and its Senses; Moral Issues - dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, Moral leadership; Codes of Ethics; A Balanced Outlook on Law; Engineers as responsible experimenters.

Safety and Risk - Assessment, Risk Benefit Analysis, Risk Mitigation; Responsibilities and Rights - Confidentiality, Conflicts of Interest, Employee Rights, Intellectual Property Rights, Corporate Social responsibility; Occupational Crime, Discrimination; Environmental Ethics, Industrial Geotechnical Ethics- Engineers as managers-Case studies.

Total Hours: 15

TEXT BOOKS

1. M. Govindarajan, S.Natarajananad, V.S.SenthilKumar, "Engineering Ethics includes Human Values", PHI Learning Pvt Ltd, 2nd Edition,2009.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 3rd Edition, 2003.

REFERENCES

1. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, Engineering Ethics - Concepts and Cases, Cengage Learning, 12th Edition, 2009.
2. Laura P. Hartman and Joe Desjardins, Business Ethics: Decision Making for Personal Integrity and Social Responsibility McGraw Hill education, India Pvt.Ltd., New Delhi, 3rd Edition, 2013.

WEB REFERENCES

1. https://nptel.ac.in/courses/110/105/110105097/
2. www.nspe.org
3. https://books.google.co.in/books?id=CWMSAAAAQBAJ

ENLIGHTENMENT THROUGH EDUCATION
SREC

MANDATORY COURSES (MAC)

ENLIGHTENMENT THROUGH EDUCATION
SREC

MANDATORY COURSES (MAC)

These courses include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC.etc.

All Students shall enroll, for atleast one course from Personality and Character Development category and one course from Allied Skills category listed below in addition to one course from the Additional Courses prescribed in the curriculum of the Programme concerned for the award of degree.

Category	Course Title	
Personality and Character development	Sports & Games	Any one Course
	Empowerment through Yoga	
	National Cadet Corps	
	National Service Scheme	
	Youth Red Cross	
	Extra/Co-Curricular Activities	
	Soft skills	
Allied Skills	English Proficiency Certification	Any one Course
	Foreign/ Vernacular Languages	
	Technical Certification Courses	
Additional Courses	Mandatory courses recommended by the Career Development and Placement Division	Any one Course
	Bureau of Overseas Education	
	Entrepreneur Development Cell	

Given below are the set of rubrics for the students to follow for the mandatory courses.

Rubrics are **multidimensional sets of scoring guidelines** that can be used to provide consistency in evaluating student work. It is an assessment tool that clearly indicates achievement criteria across all the components of any kind of student work, from written to oral to visual. **In order to take any Mandatory course, he/she should be a bonafide student of SREC.**

INSTITUTIONAL ACTIVITIES

S.No	Course code	Course title	Faculty Advisor
1	20MC201	Sports and Games	Physical Director
2	20MC202	Empowerment through Yoga - Yoga & Meditation club	Faculty In charge
3	20MC203	National Cadet Corps	Associate NCC Officer
4	20MC204	National Service Scheme	Programme Officer
5	20MC205	Youth Red Cross	Programme Officer
6	20MC206	IEEE - Institute of Electrical and Electronics Engineers – Student Branch ➢ IEEE Women in Engineering ➢ IEEE Computer Society ➢ IEEE Engineering in Medicine and Biology Society	Faculty In charge
7	20MC207	Women empowerment Cell	Faculty In charge
8	20MC208	Soft skills	Faculty In charge
9	20MC209	English Literary Society	Faculty In charge
10	20MC210	Science Association	Faculty In charge
11	20MC211	ISTE-students chapter	Faculty In charge
12	20MC212	Tamil Mandram	Faculty In charge
13	20MC213	Renewable Energy club	Faculty In charge
14	20MC214	Philatelic club	Faculty In charge
15	20MC215	Phorartz club	Faculty In charge
16	20MC216	Quiz club	Faculty In charge
17	20MC217	Fine arts club	Faculty In charge
18	20MC218	Reading Club	Faculty In charge
19	20MC219	Red Ribbon club	Faculty In charge
20	20MC220	Robo club	Faculty In charge
21	20MC221	Uyir club	Faculty In charge
22	20MC222	YI YUVA	Faculty In charge
CSE			
1	20MC011	Association of Computer Engineers	Faculty Advisor
2	20MC012	Computer Society of India(Common to CSE,IT and AIDS)	Faculty Advisor
3	20MC013	Artificial Intelligence Club	Faculty In charge
4	20MC014	Foss club	Faculty In charge
5	20MC015	Nature club	Faculty In charge

ECE			
1	20MC021	Association of Electronics and Communication Engineering	Faculty Advisor
2	20MC022	Institute of Electronics and Telecommunication Engineers Students Chapter	Faculty Advisor
3	20MC023	Social Innovation Club	Faculty In charge
EEE			
1	20MC031	Association of Electrical and Electronics Engineering	Faculty Advisor
2	20MC032	Indian Association for energy management professionals -IAEMB	Faculty Advisor
MECHANICAL			
1	20MC041	Mechanical Engineering Association	Faculty Advisor
2	20MC042	Institution of Engineers (IE)	Faculty Advisor
3	20MC043	Society of Automotive Engineers(SAE)	Faculty Advisor
IT&AIDS			
1	20MC051	Information Technology Engineers Association	Faculty Advisor
2	20MC052	Software development and information storage club	Faculty In charge
EIE			
1	20MC061	Association of Electronics and Instrumentation Engineers	Faculty Advisor
2	20MC062	Instrument Society of India	Faculty Advisor
3	20MC063	Social Development club	Faculty In charge
BME			
1	20MC071	Association of Biomedical Engineering	Faculty Advisor
2	20MC072	Biomedical Engineering Society of India	Faculty Advisor
4	20MC073	Biomedical Social Outreach club (BMSOC)	Faculty In charge
AERO			
1	20MC081	Aeronautical Engineers Association	Faculty Advisor
2	20MC082	SEDS India Students Chapter	Faculty Advisor
3	20MC083	Aero Modelling club	Faculty In charge
CIVIL			
1	20MC091	Association of Civil Engineering (CIVEANZ)	Faculty Advisor
2	20MC092	Indian Geotechnical Society	Faculty Advisor
3	20MC093	Green Kalam club	Faculty In charge
4	20MC094	Indian Concrete Institute	Faculty Advisor
		ROBOTICS AND AUTOMATION	
1	20MC101	Robotics and Automation Association	Faculty Advisor

ALLIED SKILLS

The candidate under regulation 2020 has to complete the specified proficiency levels in any one of the following languages during his/her period of study.

Sl.No	Course code	Name of the Language	Prerequisite	Eligibility	Faculty Advisor
1	20MC271	English	BEC Preliminary (148 and above)	B2 Level (BEC Vantage)	English Department Faculty Coordinator
2	20MC272	Spanish	-	Basic Spanish	
3	20MC273	Hindi	Prathmic	Madhyama	
4	20MC274	Hindi	-	Basic Spoken Hindi	
5	20MC275	Technical Certification	Respective Department Faculty Coordinator		

ADDITIONAL COURSES

Sl.No.	Course code	Course title	Faculty Advisor
1	20MC291	Career Development and Placement Division - Employability and Enhancement Course	Faculty Advisor
2	20MC292	Bureau of Overseas Education	Faculty Advisor
3	20MC293	Entrepreneurship Development Centre	Faculty Advisor

RUBRICS FOR PERSONALITY AND CHARACTER DEVELOPMENT

20MC201 - SPORTS and GAMES

Sports and games allow individuals to learn, develop and can provide opportunities that support their physical, cognitive, social, and emotional development.

Physical Education Grading and Rubric score for effort, Sportsmanship, Cooperation & Attendance, High Level of Participation. Participation in game/activity >90% always puts forth personal best effort.

Eligibility: 1st year students

Duration: 50 hours per year

Criterion	Outstanding(5)	Excellent (4)	Good (3)	Adequate (2)	Poor (1)
Frequency of Participation in Events/ Promptness	He /She attends the 90% of sessions	He /She attends the 80% of sessions	He /She attends the 70 % of sessions	He /She attends the 60% of sessions	He /She attends the sessions less than 50%
Engagement/ Activeness	He/ She always engaged in all the sessions	He/ She always engaged in 80% of the sessions	He/ She always engaged in 70% of the sessions	He/ She always engaged in 60% of the sessions	He/ She does not show keen interest
Competence	He / She delivers 90% effort in all the activities	He / She delivers 80% effort in all the activities	He / She delivers 70% effort in all the activities	He / She delivers 60% effort in all the activities	He / She not as much of effort in minimum activities
Achievements	He/ She attains laurels / participated in the University level tournaments	He/ She attains laurels/ participated in the Anna University IZ/ TIES / Open State level tournaments	He/ She attains laurels/ participated in the Anna University Zonal / Open Inter collegiate, District level tournaments	He/ She attains laurels/ participated in the Intramural tournaments	He/ She not attains laurels / participated in the any level of scheduled tournaments in the stipulated period
Leadership skills	90% aware of own potential and organizes and lea d the group	80% aware of own potential and organizes and lead the group	70% aware of own potential and organizes and lead the group	60% aware of own potential and organizes and lead the group	He /She requires significant assistance in organizing and leading the group

20MC202 - EMPOWERMENT THROUGH YOGA

Yoga is a path towards total harmony of body, mind, and spirit. It is an inherent desire in humans to be happy.

Yoga activities help to maintain the Physical and mental health.Yoga Techniques helps to develop the attitude of Love and Compassion. It is useful to understand the cause and effect system of Nature.

Eligibility: 1st, 2nd and 3rd year students

Duration: 45 hours

Yoga Skills	Outstanding (5)	Excellent (4)	Good (3)	Adequate (2)	Poor (1)
Readiness	Student is always very eager to begin the yoga lesson.	Student is always ready and willing to begin yoga lesson.	Student is fairly ready and willing to begin yoga lesson.	Student is rarely ready and able to begin the yoga lesson.	No Efforts
Breathing	Extraordinary at deep breathing exercises. Allows breath to run the mind. Is able to inhale and exhale for prescribed duration during exercises.	Great at deep breathing exercises. Allows breath to run the mind. Is able to inhale and exhale for prescribed duration during exercises.	Able to do some deep breathing practices. Inhale and exhale from 5-10 seconds during breathing exercises.	Shallow breathing, at the Wor st case. not being able to inhale and exhale for longer than 4-5seconds each during breathing exercise and asana's	No Efforts
Focus/ Concentration	Excitedly perseveres and concentrates when Learning /holding poses. Always participates actively, willingly, and excitedly, applies and transfers learning. Models for peers.	Strongly perseveres and concentrates when Learning /holding poses. Always participates actively, willingly, and excitedly, applies and transfers learning.	Usually perseveres when learning/holding poses. Participates actively with infrequent, gently reminders to follow instruction and remain on task.	Fairly perseveres when learning/holding poses. Participates actively within frequent, gently reminders to follow instruction and remain on task.	No Efforts
Technique	Always has the Pose/Mudra/ Bandhaexcellently executed with all lines/shapes intact.	Always has the Pose/Mudra/ Bandhacomplement arily executed with all lines/shapes intact.	Usually has the Pose/Mudra/ Bandhamoderately executed with all lines/shapes, or if not, needs minor adjustments to form and is willing/able to make adjustments.	Usually either has the Pose/Mudra/Bandhasati sfactorily executed with all lines/shapes, or if not, needs minor adjustments to form and is willing/able to make adjustments.	No Efforts
Flexibility	Expertise in execution of all the pose with all lines/shapes. Minor adjustments are made on his/her own. A model for peers.	Excellent in execution of all the pose with all lines/shapes. Minor adjustments are made on his/her own.	Almost always has the pose strongly executed with all lines/shapes. Minor adjustments are easily made and accepted.	Usually has the pose moderately executed with most lines/shapes. If not, needs only minor adjustments to form and is willing/able to make adjustments.	Has difficulty in understanding how to translate oral direction to the body shape/for.

20MC203 - NATIONAL CADET CORPS

The NCC provides opportunities to the youth of the country for their all-round development with a sense of Duty, Commitment, Dedication, Discipline and Moral Values so that they become leaders and useful citizens. The NCC provides exposure to the cadets in a wide range of activities with a distinct emphasis on Social Services, Discipline and Adventure Training.

Eligibility: Should be Citizen of India and satisfy the standards of physical fitness

Duration: 3 years (120 hours/year and 1 Camp compulsory)

Discharge of cadets: Students do not have minimum attendance required for regular parades

and camps or found medically unfit.

Number of student's enrolment per year: 17

Criterion	Outstanding (5)	Excellent (4)	Good (3)	Average (2)	Poor (1)
Frequency of participating in parades	Students participating in all the parades and a camp	Students participating in more than 90% of parades and a camp	Students participating in 81 % and above of parades and a camp	Students participating in 75 - 80 % of parades and a camp	Students participating in less than 75% of parades and no camp
Leadership, communication skills& team work	Students show 100 % success in leading the group and completing the task	Students show 90 % success in leading the group and completing the task	Students show 75 % success in leading the group and completing the task	Students show 50 % succes s in leading the group and completing the task	Students show less than 25 % success in leading the group and completing the task
Adventure activities	Participation and completion of the task assigned	Participation and completion of the 80% task assigned	Participation and completion of the 70 % of the task assigned	Participation in the task	No efforts
Social service and Community development activities	Participation and show extraordinary involvement in discharging Social service and community development activities	Participation and show great involvement in discharging Social service and community development activities	Participation and show recognizable involvement in discharging Social service and community development activities	Participation and show satisfactory involvement in discharging Social service and community development activities	Lack of participation and involvement in discharging Social service and community development activities

Certificate examination: B certificate compulsory at the end of 2nd year, C certificate compulsory at the end of 3rd year

20MC204 / 20MC205 - NATIONAL SERVICE SCHEME/YOUTH RED CROSS

The aim of National Service Scheme is personality development through social service or community service. NSS helps the student to grow individually and also as a group. It makes the students confident, develop leadership skills, and gain knowledge about different people from different walks of life.

NATIONAL SERVICE SCHEMEYOUTH RED CROSS

Eligibility: 1st and 2nd year studentsEligibility: 2nd,3rd and Final year students

Duration: 2 years (240 hours with 1 Special camp compulsory) **Duration: 40 Hours**

Number of student's enrolment per year: 150

Criterion	Outstanding (5)	Excellent (4)	Good (3)	Adequate (2)	Poor (1)
Frequency of participation in events	Students participating in all the events and a special camp	Students participating in more than 90% of events and a special camp	Students participating in 75% of events and a special camp	Students participating in 50% of events and a special camp	Students participating in less than25% of events and no special camp
Team work and coordination among group members	Students are able to show maximum cooperation among team members with ethical behavior	Students show good cooperation among team members with ethical behavior	Students show fairly good cooperation amongteam members with ethical behavior	Students show moderate cooperation amongteam members with ethical behaviour	Students show less cooperation amongteam members with ethical behaviour
Leadership Skills	Students show excellent involvement and demonstrate social responsibility in organizing events	Students have very good involvement and demonstrate social responsibility in organizing events	Students have fair involvement and demonstrate social responsibility in organizing events	Students have adequate involvement and demonstrate social responsibility in organizing events	Students have poor involvement and demonstrate social responsibility in organizing events
Communication and learning skills	Students are able to communicate very well with public and learn behavioural skills	Students are able to communicate well with public and learn behavioural skills	Students are able to communicate fairly well with public and learn behavioural skills	Students are able to communicate moderately with public and learn behavioural skills	Students are not able to communicate well with public and learn behavioural skills
Civic Engagement	Students give outstanding participation in activities of public concern for individual life and social benefits of the community	Students give very good participation in activities of public concern for individual life and social benefits of the community	Students give fairly good participation in activities of public concern for individual life and social benefits of the community	Students participation in activities of public concern for individual life and social benefits of the community is satisfactory	Studentsparticipation in activities of public concern for individual life and social benefits of the community is unsatisfactory

20MCXXX - PROFESSIONAL SOCIETIES

Jointly proposes the following Rubrics for Personality and Character Development one credit course (likeIE, CPC,ISTE STUDENT CHAPTER, SAC, IEEE, ISTEIETE, CSI, WOMEN IN ENGINEERING - IEEE, ISOI, BMESI, IGS, SEDS INDIA AND MBA-CMA, etc.,)

Involvement with a professional society will afford the participant an opportunity to network with other colleagues in industry and practice. Joining a professional organization is critical in keeping abreast of the latest knowledge and practices locally, regionally, and globally. An active participant will have the opportunity to serve in professional development. There will be possibilities for making real contributions to the human condition through projects the professional organization may take on as a part of giving back to the community. There are events that will call for public speaking skills and professional visibility which will assist in moving one's career to another level by connecting with other professionals and local leaders in the area. Being a member of a professional organization is a symbiotic relationship between the organization and the member that will benefit them both.

Eligibility: 1st and 2nd year students

Duration: 40 hours

Criterion	Outstanding (5)	Excellent (4)	Good (3)	Adequate (2)	Poor (1)
Organizational involvement	Student has 100% participation through membership in the activities related to any reg istered student society	Student has 90% participation through membership in the activities related to any registered student society	Student has 75 % participation through membership in the activities related to any registered student society	Student has 6 0% participation through membership in the activities related to any registered student society	The student require significant assistance (less than 50% success)
Frequency of Participation in Events	The students participating in more than 90% of events	The students Participatingin 80 % of events	The students participating in 70 % of events	The students participating in 60 % of events	The students participating in less than 50 % of events
Team work	The student engages exceptionally with team me mbers and treats team members respectfully, motivates teammates by expressing confidence	The student excellently engages with team members and treats team members respectfully, motivates teammates by expressing confidence	The student strongly engages with team members and treats team members respectfully	The student fairly engages with team members and treats team members respectfully	The student engages less with team members
Leadership skills	Student has 100% involvement,respo nsibility or accomplishment in planning, leading managing and organizing events	Student has 90 % involvement,responsi bility or accomplishment in planning, leading managing and organizing events	Student has 75% involvement,respon sibility or accomplishment in planning, leading managing and organizing events	Student has 60% involvement,respo nsibility or accomplishment in planning, leading managing and organizing events	Student has less than 50% involvement,respo nsibility or accomplishment in planning, leading managing and organizing events

20MCXXX - ALL TECHNICAL ASSOCIATIONS AND CLUBS OF VARIOUS DEPARTMENTS

Jointly proposes the following Rubrics for Personality and Character Development one credit course

Clubs and organizations are a great way to help develop your character and the skills that will benefit your career and in life. Skills like commitment, leadership, effective communication, and being able to work successfully in a group all come from participating in a club. Your participation will reflect your interest and knowledge in extra-curricular activities thereby making you an all-rounder

Eligibility: 2nd year students

Duration: 40 hours

Criterion	Outstanding(5)	Excellent(4)	Good(3)	Adequate(2)	Poor(1)
Frequency of participationin Events	The students participating in more than 90%of events	The students participating in80 % ofevents	The students participating in 70 % of events	The students participating in 60 % of events	The students Participating inlessthan 50 % of events
Student engagement/ commitment	The student is always well-focused and very activelyengaged in all theevents	The student is well-focused and actively engaged in events	The student iswell-focused and fairly engaged inevents	The student is focusedand moderatelyengaged inevents	The Student does not seek involvement, opportunities and engaged in less number of events
Team work	The student engages exceptionally withteam members and treats teammembers respectfully, motivates teammates byexpressing confidence	Thestudent excellently engages withteammembersandtreatsteammembers respectfully, motivates teammates by expressing confidence	The student strongly engages with team membersand treats team members respectfully	The student fairly engages with team membersand treats team members respectfully	The student engages Lesswithteammembers
Organization and ManagerialSkills	Outstandingawarenessof ownpotential and plan, organizes, lead, managemorenumber ofevents	Qualityawarenessofown potential and plan, organizes, lead, manage more number ofevents	Enhanced awarenessof Ownpotential Andplan, organizes, lead, manage more number of events	The student is hesitant but abletoleadand empowergroup members	The student requires significant assistance in leading and empowering group members
Communication/ Learning skills	Organizational Patternis clear and consistent, polished; makes the content cohesive.Consistently identifieslearning opportunities, criteria, choices, and strategiesto meet personal needs and achievegoals	Organizational pattern is clear andconsistent. Usually identifies learning opportunities, criteria, choices, and strategies to meet personal needs and achievegoals	Message is Basicallyunderstandable but is notreinforced. Sometimes identifies learning opportunities	Adequate with Incompleteexplanations,examples, descriptions. Rarely identifies learning opportunities	Demonstrates minimal Attentionto the context and uses unclear language to the audience.Not identifying learningopportunities

20MC208 : SOFT SKILLS
LEADERSHIP AND WORKPLACE ETIQUETTE

Course Outcomes

On completion of the course, the students will be able to

CO1	Learn professional communication and its significance in the workplace.	PO10, PO12
CO2	Use effective interpersonal communication to acquire leadership skills.	PO10, PO12
CO3	Master the techniques of workplace ethics and etiquette.	PO9, PO10, PO12

Introduction to workplace communication **5**

Communication - Principles of communication- types of communication- Verbal, Non-verbal communication -Key elements of communication- Functions of communication- Communication network in an organization- Intercultural communication, Barriers of communication -Social media communication.

Leadership Skills and Team Management **5**

Qualities of a Leader- Decision making, identifying the problem, Problem solving skills- Cognitive skills -Lateral thinking skills- Presentation skills- Group discussion-Coping with workplace realities- Interpersonal skills-Team Management- Effective team player- Interview skills- Mock interview.

Professional Ethics and Corporate Etiquettes **5**

Importance of Ethics and values- Ethical dilemma, choices and dilemmas faced, Office Etiquette-Telephone and Email Etiquette-Grooming Etiquette-Dining Etiquette.

Total: 15 hours

Text Book

Frederick H. Wentz Soft Skills Training: A Workbook to Develop Skills for Employment- Create Space Independent Publishing Platform; Large edition, 2012

Reference Books

1. M.S.Rao- Soft skills- I.K. International publishing House pvt.ltd: Bangalore, 2011.
2. GeetuBharwaney- Increase your emotional Intelligence- Jaico publishing house: Delhi, 2009.
3. R.C.Bhatia- Personality Development- Ane books private ltd: Delhi, 2013.

Web References

1. https://courses.lumenlearning.com.
2. https://www.thebalancecareers.com

ASSESMENT PATTERN FOR
20MC208 SOFT SKILLS-LEADERSHIP AND WORKPLACE ETIQUETTE

On completion of this course, the candidate will master Workplace Communication and Etiquette, Leadership Skills, Team Work and Corporate Ethics. Soft Skills is a 15 hour course and the candidate is expected to complete his/ her opted course during his/her period of study (second - sixth semesters).

Criterion	Outstanding(5)	Excellent(4)	Good(3)	Inadequate(2)	Poor(1)
Participation in the event	100% participation and involvement	80% participation and involvement	60 % participation and involvement	40% participation and involvement	20% or below participation and involvement
Collaboration	Acts as a leader member. Consistently provides thoughtful ideas in teams.	A strong team member. Values and encourage ideas and team members.	Participates and sometimes requires prompting.	Rarely provides idea and strong prompting required	Does not provide any idea and rarely values and encourages team members.
Respect	Seeks and accepts the opinion and input of others.	Listens and accepts the opinions of others.	Shows progress in accepting opinion.	Sometimes accepts opinion.	Usually ignores the opinion and input from others.
Initiative	Initiates curiosity and interest in learning. Independently engages in learning activities and high perseverance.	Demonstrates Curiosity and interest in learning. Demonstrates Resourcefulness.	Shows progress in resourcefulness and seeks assistance at times.	Seldom demonstrates And rarely engages in learning activities.	Never shows interest in learning activities. Rarely uses assist with forcing it.
Enthusiasm in delivery	Prefect and easy flow of thoughts. Holds attention, speaks with fluctuation in volume to maintain interest of the audience.	Clear flow of thoughts Consistent use variations in tone to keep in contact with audience.	Most of the thoughts are clear and not effective. Speaks satisfactorily variation of volume and tone.	No clear thoughts and flow. Speaks in uneven tone.	Flow of thoughts is confusing. Speaks in no variation in tone.
Habits	Always punctual and prepared. Consistently displays a positive attitude.	Always on task and strives to reach full potential. Ensures to do well.	Stays on task. Strives to meet potential.	Occasionally Punctual and prepared. Beginning to strive to meet potential.	Seldom punctual and prepared. Needs to remain focused on task.

ADDITIONAL COURSES

20MC291 - EMPLOYABILITY ENHANCEMENT COURSE

(General Aptitude)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1:	Improve on the Deductive and Logical skills.
CO2:	Understand, analyze and perfect a solution.
CO3:	Improve the numerical and conceptual ability.
CO4:	Improve the ability to use measurable data and get reliable results.
CO5:	Demonstrate a better capability for analytical and conceptual thinking.
CO6:	Recognize and comprehend pattern quickly and solve the problems perfectly.
CO7:	Improve the real time engineering and calculative skills.
CO8:	Understand grammatical structure on written and spoken form.

Quantitative Aptitude: **45**

Basic Mathematics and Analytical Ability

Percentages, Profit, Loss and Discount, Simple Interest and Compound Interest, Number Systems: LCM and HCF-unit digit and last two digit- Remainder theorem concept, Ratio and Proportion: Partnership problems- Races and games-problems based on coins-proportionality and variation, Allegation and Mixtures, Mensuration - Areas and Volumes.

Engineering and Applied Mathematics

Averages, Algebra - word problems, Time and Work, Pipes and cisterns, Time and distance-concept of average speed, relative speed Trains, boats and streams, circular motion. Permutation and combination, Probability, concept of areas, Calendars and clocks, Elementary Statistics-measure of central tendency, standard and mean deviation.

Reasoning Ability: **30**

Deductive Reasoning

Analogy and odd man out, Alphabet and number series; Blood relations, Coding and decoding; Directions and distance, Linear seating arrangement; Circular seating arrangement; Puzzles; Inequality.

Inductive& Critical Reasoning

Statements and action; Statement and assumptions; Statement and Conclusions, Syllogism; Data interpretation; Data sufficiency; Venn diagram based; Visual reasoning-paper cutting, folding, image formation, picture analogy, mirror and water images, Cubes and Dices.

Verbal Ability: **15**

Verbal Analogies, Vocabulary-Synonyms and Antonyms, Sentence Correction, Reading Comprehension, Parajumbles.

Total Hours: 90

REFERENCES

1. Edgar Thrope, "Test of Reasoning for Competitive Examinations", Tata McGraw Hill, 4th Edition, 2014
2. Sijwali.B.S, "A New Approach to Reasoning Verbal & Non-Verbal", Arihant Publication 2015.
3. Anand.P.A, "Quantitative Aptitude", Wiley Publication, 2015.
4. AbhijitGuha, "Quantitative Aptitude for Competitive Examinations", Tata McGraw Hill, 3rd Edition, 2015
5. Thorpe Edgar and Thorpe Showich, "Objective English", Pearson Education 2016.
6. Bakshi.S.P, "Objective General English", Arihant Publication 2015.

ASSESMENT PATTERN FOR
20MC291 - EMPLOYABILITY ENHANCEMENT COURSE

Among the advantages, grading students' performance that relies on higher order thinking or complex matters combined with training to make basic analytics without calculators. By developing techniques to analyze, interpret and synthesize data, depth understanding by using relevant and accurate detail by coherence and progression of data is developed. Refined choice of language and sentence structure and purposeful demonstrating of command of the language and a variety of usage of sentence structure is focused for development.

Eligibility: 2nd and 3rd year students

Duration: 45 hours per academic year

GENERAL APTITUDE

Criterion		Outstanding (5)	Excellent (4)	Good (3)	Inadequate (2)	Poor (1)
Quantitative Aptitude	Participation Training	100% participation and involvement	80% participation and involvement	60 % participation and involvement	40% participation and involvement	20% or below participation and involvement
	Application - Calculation Skill without calculators	Exemplary work. No mistakes. Well organized. Excellent understanding	Adequate level of work. It could be improved. Good level of understanding.	Minimum acceptable work. Many minor mistakes. Some understanding.	Some mistakes. Several major mistakes. Limited understanding	Mostly wrong. No understanding.
Verbal Ability	Participation Training	100% participation and involvement	80% participation and involvement	60 % participation and involvement	40% participation and involvement	20% or below participation and involvement
	Skill-vocabulary and Grammar Ability	Excellent knowledge of vocabulary. Excellent at identifying word meanings. Student demonstrates very high command of grammatical and usage patterns. The student is excellent in manipulating the language with accuracy and confidence.	Good vocabulary. Good at identifying word meanings. Good at grammatical and usage pattern. Good at manipulating the language. Some minor discrepancies do not interfere with competence.	General vocabulary knowledge. The student has internalized grammatical usage with some accuracy and confidence. Some error impairs linguistic performance.	Insufficient of vocabulary knowledge. The student does not manipulate the language to express meaning.	Insufficient of vocabulary knowledge. The student has not internalized grammatical and usage patterns. A large number of grammar and usage errors.
Reasoning Ability	Participation Training	100% participation and involvement	80% participation and involvement	60 % participation and involvement	40% participation and involvement	20% or below participation and involvement
	Analysis- Interpretation of data, numbers, tables, Synthesis of data	Exemplary work. No mistakes. Well organized. Excellent understanding	Adequate level of work. It could be improved. Good level of understanding.	Minimum acceptable work. Many minor mistakes. Some understanding.	Some mistakes. Several major mistakes. Limited understanding	Mostly wrong. No understanding

20MC292 - BUREAU OF OVERSEAS EDUCATION

The aim of Bureau of Overseas Education (BoE) is to create an awareness on higher education opportunities available abroad through arrangement of seminars, training classes for competitive exams like GRE, TOEFL, IELTS etc. It also encourage students to study any relevant foreign languages.

Eligibility: 3rd and 4th year students

Duration: 2 years

Requirement: To fulfill any 4 criteria

Criterion	Outstanding (5)	Excellent (4)	Good (3)	Adequate (2)	Poor (1)
Frequency of participation in various seminars and guest lectures	Students participating in all the lectures	Students participating in more than 80% of lectures	Students participating in 70% of lectures	Students participating in 50% of lectures	Students participating in less than 25% of lectures
Attending training sessions for GRE, TOEFL, IELTS etc	Participation with 100 % attendance	Participation with 80 % attendance.	Participation with 70 % attendance	Participation with 50 % attendance	Participation with less than 25 % attendance
Publication of project work in Journal and conference presentations	Students with a minimum number of 1 publication in Scopus indexed Journal with an impact factor.	Students with a minimum number of 1 publication in Scopus indexed journal without an impact factor.	Students with a minimum number of 1 presentation and publication in Scopus indexed conference.	Students with a minimum number of 1 presentation and publication in any conference.	Students with a minimum number of 1 presentation/participation any conference
Internship	Students with an internship in a foreign University of developed country/ IITs/ IISc /IIITs/ Government approved research institutes.	Students with an internship in any NITs/ Central Government Universities/ Public sector companies/ Fortune India 500 companies.	Students with an internship in any foreign University.	Students with an internship in any State Government/ aided institutions.	Students with an internship in any industry.
Communication skills with certification like BEC, Japanese, etc.,	Students showing 100% success with any one language certification	Students showing 90% success with any one language certification	Students showing 80% success with any one language certification	Students showing 70% success with any one language certification	Students showing 60% success with any one language certification
Online certification course related to their field of interest / higher education from online platforms like NPTEL, Coursera, Udemy, etc.,	Students with more than 4 online certifications	Students with 4 online certifications	Students with 3 online certifications	Students with 2 online certifications	Students with one online certification

20MC293-ENTREPRENEURSHIP DEVELOPMENT CENTRE (EDC)

The objectives of the centre is to inculcate a culture of innovation driven entrepreneurship, to channelize the knowledge and the energy of youth towards becoming active partners in the EDC and to catalyse&promote development of knowledge-based and innovation-driven enterprises and promote employment opportunities amongst youth specially students.

Eligibility: 1st, 2nd and 3rd Years

Duration: 40 hours

	Outstanding (5)	**Excellent (4)**	**Good (3)**	**Adequate (2)**	**Poor (1)**
Frequency of Participation in the events	Student should possess 100% participation	Student should possess 90% participation	Student should possess 75% participation	Student should possess 60% participation	The student require significant assistance (less than 50% participation)
Ideation	More than 90% innovation and novelty	80 - 89 % of innovation and novelty	70 - 79 % of innovation and novelty	60 - 69 % of innovation and novelty	less than 50 % of innovation and novelty
Team work	The student engages exceptionally with team members and treats team members respectfully, motivates teammates by expressing confidence	The student excellently engages with team members and treats team members respectfully, motivates teammates by expressing confidence	The student strongly engages with team members and treats team members respectfully	The student fairly engages with team members and treats team members respectfully	The student engages less with team members
Entrepreneurial Skillsets	Student has 100% involvement,responsibility or accomplishment in leadership, Task oriented, Passion and risk taking ability	Student has 90 % involvement, responsibility or accomplishment in leadership, Task oriented, Passion and risk taking ability	Student has 75% involvement, responsibility or accomplishment in leadership, Task oriented, Passion and risk taking ability	Student has 60% involvement, responsibility or accomplishment in leadership, Task oriented, Passion and risk taking ability	Student has less involvement, responsibility or accomplishment in leadership, Task oriented, Passion and risk taking ability
Outcome of a Business Plan	Startup creation and access to funding	Commercialization	Product Validity	Proof of Concept	Not Devised / Formulated

B.E. MECHANICAL ENGINEERING

ENLIGHTENMENT THROUGH EDUCATION
SREC

DEPARTMENT OF MECHANICAL ENGINEERING

The department of Mechanical Engineering established in the year 1994, offers B.E. (Mechanical Engineering) and M.E. (Manufacturing Engineering) program and is permanently affiliated to Anna University, Chennai. It is also recognized research department by Anna University, Chennai offering Ph.D program. The Undergraduate program was accredited in the year 2003,and reaccredited in 2007, 2012 and 2015 by NBA, New Delhi.

VISION AND MISSION OF THE DEPARTMENT

VISION

- The Department of Mechanical Engineering excels in Engineering Education and building enterprising professionals, encompassing creativity, innovation, research, employability and entrepreneurship, meeting the requirements of the society.

MISSION

- To provide quality engineering education that equips the students with adequate knowledge in mechanical engineering to become successful professionals.
- To prepare the students with effective communication skills, intellectual abilities, teamwork and professional ethics for valuable contribution to the society.
- To facilitate the students in orienting towards research and life-long learning to meet the needs of the stakeholders.

Programme Educational Objectives (PEOs)

The graduates of this program, after four to five years, will

PEO1: Offer rationale solutions in designing and manufacturing of mechanical as well as allied engineering systems through the acquired knowledge in Mathematics, Physical Science, Engineering and Technology.

PEO2: Demonstrate the professional and entrepreneurial skills with confidence to seek solutions to the tasks with due consideration on social, environmental, economical and ethical values.

PEO3: Communicate effectively and engage in life-long learning for professional and personal growth.

Program Outcomes and Program Specific Outcomes (POs and PSOs)

Program Outcomes as stated by NBA: Engineering Graduates will be able to

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes:

Mechanical Engineering students at the time of graduation will be able to

PSO1: Design, model and analyze mechanical components and systems using computational engineering tools.

PSO2: Plan the manufacturing processes of mechanical components and systems corisidering quality, cost and safety.

PSO3: Identify and evaluate the thermal and heat transfer properties of mechanical systems.

Category wise distribution of credits

S. No	Category	Credits per Semester								Credits Total
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Sciences(HS)	3	3	1	-	2	-	-	-	9
2	Basic Sciences(BS)	8	8	3	4	-	-	-	-	23
3	Engineering Sciences(ES)	9	4	11	2	5	-	-	-	31
4	Professional Core(PC)	-	7	7	13	10	20	-	-	57
5	Professional Electives(PE)	-	-	-	-	3	3	12	-	18
6	Open Electives(OE)	-	-	3	3	3	-	-	-	9
7	Employability Enhancement Course(EEC)									
	I. Project work	-	-	-	2	-	2	-	8	12
	II. Mandatory Courses	-	-	-	-	-	-	2	-	2
	III. One Credit Course	-	-	-	-	-	-	1	-	1
	Total	20	22	25	24	23	25	15	8	162

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

PROFESSIONAL CORE										
S. No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**POs**	**CA**	**ES**	**TOTAL**
1	20ME206	Thermal Engineering	2	1	0	3	1,2,7	40	60	100
2	20ME207	Materials Engineering	2	0	0	2	1,2,12	40	60	100
3	20ME209	Additive Manufacturing Technology	2	0	0	2	1,5,11	40	60	100
4	20ME274	Thermal Engineering lab & Metallurgy Lab	0	0	3	1	1,2,4,7,9,10	60	40	100
5	20ME275	Manufacturing Technology Lab	0	0	3	1	1,2,9,10,12	60	40	100
6	20ME276	Computer Aided Modeling and 3D Printing Lab	0	0	3	1	1,2,5,9, 10,12	60	40	100
7	20ME210	Kinematics of Machinery	2	1	0	3	1,2,5,10	40	60	100
8	20ME212	Electric Vehicle Technology	2	0	0	2	1,7,12	40	60	100
9	20ME277	Design for Manufacturing Lab	0	0	3	1	1,2,3,5, 9,10,12	60	40	100
10	20ME214	Design of Machine Elements	2	1	0	3	1,2,3,4	40	60	100
11	20ME215	Thermal Systems and Gas Dynamics	2	1	0	3	1,2,3	40	60	100
12	20ME216	Industrial Automation	3	0	0	3	1,2	40	60	100
13	20ME217	Mechanical Measurements and Metrology	3	0	0	3	1,2,5	40	60	100
14	20ME252	Dynamics of Machinery and Laboratory	2	1	2	4	1,2,3,4,9, 10,12	50	50	100
15	20ME279	Metrology Lab and Materials Testing Lab	0	0	3	1	1,4,5,9, 10,12	60	40	100
16	20ME219	Finite element method	3	0	0	3	1,2,4	40	60	100
17	20ME220	Design of transmission systems	2	1	0	3	1,2,3,4	40	60	100
18	20ME221	Heat transfer	2	1	0	3	1,2,3	40	60	100
19	20ME222	Industrial engineering and cost estimation	2	0	0	2	1,2,4,10,11	40	60	100
20	20ME223	Digital manufacturing	2	0	0	2	1,2,5,12	40	60	100
21	20ME224	AI for mechanical engineers	2	0	0	2	1,2,4,12	40	60	100
22	20ME280	Automation Laboratory and Heat Transfer Laboratory	0	0	3	1	1,2,3,4,5, 9,10,12	60	40	100
23	20ME281	Computer aided Analysis and Fluid flow Laboratory	0	0	2	1	1,2,4,5,9, 10,12	60	40	100

S. No.	Course Code	Course Title	L	T	P	C	POs	CA	ES	TOTAL
PROFESSIONAL CORE (PC)										
1	20ME253	Materials Engineering and Metallurgy	2	0	2	3	1,2,4,10,12	50	50	100
2	20ME254	Mechanical Measurements and Metrology	2	0	2	3	1,2,3,5,9,10	50	50	100
3	20ME285	Thermal Engineering & Materials Testing Laboratory	0	0	3	1	1,2,4,7,9,10	60	40	100
4	20ME286	Computer Aided Engineering Laboratory	0	0	2	1	1,2,4,5,9,10, 12	60	40	100

PROFESSIONAL ELECTIVES COURSES

S. No.	Course Code	Course Title	L	T	P	C	POs	CA	ES	TOTAL
PROFESSIONAL ELECTIVES (PEs)										
1	20ME2E02	Computer Aided Design	3	0	0	3	1,2	40	60	100
2	20ME2E03	Engineering Tribology	3	0	0	3	1,2,3	40	60	100
3	20ME2E04	Mechanical Vibration	3	0	0	3	1,2,3	40	60	100
4	20ME2E05	Machine Tool Design	3	0	0	3	1,2,3	40	60	100
5	20ME2E06	Composite Materials	3	0	0	3	1,3,12	40	60	100
6	20ME2E07	Design for Manufacturing and Assembly	3	0	0	3	1,2,3,4,6,12	40	60	100
7	20ME2E08	Metal Joining Processes	3	0	0	3	1,2,12	40	60	100
8	20ME2E09	Green and Sustainable Manufacturing	3	0	0	3	1,2,7	40	60	100
9	20ME2E10	Refrigeration and Air-conditioning	2	1	0	3	1,2,7	40	60	100
10	20ME2E11	Computational Fluid Dynamics	3	0	0	3	1,2,4,5	40	60	100
11	20ME2E12	Renewable Energy Sources and Systems	3	0	0	3	1,2,5,6	40	60	100
12	20ME2E13	Energy Storage Systems	3	0	0	3	1,2,6	40	60	100
13	20ME2E14	Industry 4.0	3	0	0	3	1,12	40	60	100
14	20ME2E15	Machine Vision System	3	0	0	3	1,2,4,5	40	60	100
15	20ME2E16	Automotive Electronics	3	0	0	3	1,2,5	40	60	100
16	20ME2E17	Ergonomics	3	0	0	3	1,2,3	40	60	100
17	20ME2E18	Micro Electro Mechanical System	3	0	0	3	1,2	40	60	100
18	20ME2E19	Operations Research	3	0	0	3	1,2,3,4	40	60	100
19	20ME2E20	Fracture Mechanics	3	0	0	3	1,2,3	40	60	100

ENLIGHTENMENT THROUGH EDUCATION
SREC

PROFESSIONAL CORE (PC)

ENLIGHTENMENT THROUGH EDUCATION
SREC

20ME206 THERMAL ENGINEERING 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Describe the construction and working principle of Internal Combustion Engines	PO1
CO2	Distinguish between various Air standard cycles	PO1, PO2
CO3	Determine the performance of Air Compressors	PO1, PO2
CO4	Estimate the performance of Refrigeration Systems	PO1, PO2, PO7
CO5	Examine Air-Conditioning Processes with the help of Psychrometric Chart	PO1, PO2
CO6	Summarize different types of Air-Conditioning Systems	PO1

INTERNAL COMBUSTION ENGINES **13**

Classifications of IC Engine - Working Principle of Two Stroke and Four Stroke SI and CI Engines and their P-V diagrams -Valve and Port Timing Diagrams. Introduction to Hybrid Vehicles.

Air standard cycles: Assumptions - Otto, Diesel, Dual - Calculation of Mean Effective Pressure and Air Standard Efficiency - Testing and performance of IC Engines - Heat Balance Sheet - Brayton cycle - Reheat and Regeneration cycles.

AIR COMPRESSORS **12**

Classification - working principle - Work of compression with and without clearance - Volumetric efficiency and Isothermal efficiency - Multistage air compressor with intercooling - Rotary compressors - types - Roots blower and Vane type blower - Comparison of Rotary and Reciprocating Air compressors.

REFRIGERATION **10**

Fundamentals of Refrigeration - Vapor Compression Refrigeration System: Working principle - Superheating and subcooling - Performance calculations - Vapor Absorption Refrigeration System - Working principle - Ammonia - Water system - Lithium bromide - Water system - Comparison between vapor compression and vapour absorption systems - Refrigerants and Eco-friendly Refrigerant Classification and properties. Introduction to ASHRAE Standards 15 and 34.

PSYCHROMETRY AND AIR-CONDITIONING **10**

Properties of atmospheric air - Psychrometric chart - Property calculations of air vapour mixtures - Psychrometric processes. Air conditioning systems - summer, winter and Year-Round Systems - Description of Window, Split and Central air conditioning systems. Introduction to ASHRAE Standard 55.

Total Periods: 45

TEXTBOOKS

1. Kothandaraman C.P, Domkundwar S and Domkundwar A.V., "A Course in Thermal Engineering", DhanpatRai& Sons, 6th Edition, 2004.
2. Ballaney P.L., "Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques", Khanna, 5th Edition, 2005.

DATA BOOK

1. Refrigeration Tables - Kothandaraman C.P, New Age International Publishers, 4th Edition, 2015.

REFERENCES

1. Rajput R.K., "Thermal Engineering", Laxmi Publishers, 10th Edition, 2018.
2. Arora C.P, "Refrigeration and Air conditioning", Tata McGraw Hill Publishing Company, 3rd Edition, 2009.

WEB REFERENCES

1. Applied Thermodynamics - http://nptel.ac.in/courses/112106133/
2. Refrigeration and Air- Conditioning - http://nptel.ac.in/courses/112105128/

20ME207 MATERIALS ENGINEERING 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Describe phase diagrams and phase transformations of metals	PO1, PO2
CO2	Outline the heat-treatment processes employed to improve the metallic properties	PO1, PO2,PO12
CO3	Relate the properties of metallic and non-metallics for relevant engineering applications.	PO1, PO2,PO12
CO4	Outline the mechanism of deformation of metallic materials	PO1, PO2

PHASE DIAGRAMS **11**

Hume-Rothery Rules, Solid Solutions, Gibb's phase rule, binary isomorphous alloy systems, non-equilibrium cooling, binary eutectic system, eutectoid, peritectic and monotectic reaction, phase diagrams with intermediate phases and compounds, Ion carbon equilibrium diagram -ternary phase diagrams-development of microstructures

HEAT TREATMENT **9**

TTT and CCT diagram, Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering. Heat treatment of non-ferrous materials

SURFACE TREATMENT

Carburizing, vacuum carburizing, nitriding, plasma nitriding, carbonitriding, flame and induction hardening

METALLIC MATERIALS **10**

Ferrous Materials - Steels - Classification of Steels - Effect of alloying on steel - Stainless steels - Maraging Steels - HSLA steels - Cast Iron and its types. Non-Ferrous Materials-Aluminium, Magnesium, Copper, Titanium - Overview of Composite Materials.

Engineering Plastics - Polyamides - Nylon 6, 66, Acetal - Homopolymer& Co-polymer, Saturated Polymers - PETP & PVTP.

Deformation Mechanisms: Dislocations - Edge and Screw - Mechanisms of plastic deformation - Slip and twinning.

Total Periods: 30

TEXT BOOKS:

1. Sidney H. Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill Publishing Co. Ltd., 2nd Edition, New Delhi, 2017.
2. Raghavan V., "Physical Metallurgy- Principles and Practice", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2015.

REFERENCES

1. Dieter George.E., "Mechanical Metallurgy ", McGraw Hill, 3rd Edition, New York, 2017.
2. Rajan.T.V, Sharma.C.P. and Ashok Sharma., "Heat Treatment - Principles and Techniques", Prentice Hall of India, 2nd Edition, New Delhi, 2010.
3. Vijendra Singh, "Physical Metallurgy", Standard Publishers Distributors, 1st Edition, New Delhi, Reprint, 2018.

Course Outcomes

On the successful completion of this course, Students will be able to

CO1	Illustrate the concept, process chain and different file formats of Additive Manufacturing	PO1, PO5
CO2	Classify different types of generic Additive Manufacturing processes and process parameters with its application	PO1
CO3	Distinguish between various additive manufacturing processes	PO1
CO4	Interpret the design guidelines in manufacturing to build model for different applications	PO1, PO11

ADDITIVE MANUFACTURING APPROACH **8**

Introduction- AM and Traditional Process- Transformation of Rapid Prototyping into Direct Digital Manufacturing - CAD Tools for AM-Generalized Additive Manufacturing Process Chain - STL file format-Access STL files repositories - Thingiverse, GrabCAD.

ADDITIVE MANUFACTURING SYSTEMS **12**

Classification of AM Processes - Process Parameters - Introduction to Generic Additive Manufacturing processes: Stereolithography Apparatus (SLA) Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Laser Engineered Net Shaping (LENS), Polyjet Technology: Working Principles, details of processes, products, materials, benefits, limitations and applications-variations from One AM Machine to Another.

ADDITIVE MANUFACTURING DESIGN PROCESS **10**

Introduction to DFAM and its comparison with Design for manufacturing (DFM), Design guidelines for AM - Material consideration, part orientation, support structure design, surface finish, minimum feature size, overall build time, build file preparation, machine setup and Cost Evaluation- The Impact of Low - Cost AM Systems.

Total Periods: 30

TEXT BOOKS:

1. "Additive manufacturing Technologies" Ian Gibson, David Rosen & Brent stucker, 2nd Edition Springer series, ISBN No:978-1-4939-2112-6, 2015.
2. "Additive Manufacturing Processes" Sanjay Kumar, Springer Nature series, ISBN 978-3-030-45089-2, 2020.
3. "A Practical Guide to Design for Additive Manufacturing"Diegel, Olaf, Nordin, Axel, Motte, Damien, Springer series for advanced Manufacturing, ISBN 978-981-13-8281-9, 2019.

REFERENCES:

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.
2. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.

20ME274 THERMAL ENGINEERING AND METALLURGY LABORATORY 0 0 3 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Determine the performance of IC Engines, Refrigeration and Air-Conditioning Systems	PO1, PO2, PO4, PO7, PO9, PO10
CO2	Examine the performance characteristics of Air Compressors and Blowers	PO1,PO2, PO4, PO9, PO10
CO3	Experiment with fuels to identify their properties	PO1,PO2, PO4, PO7, PO9, PO10
CO4	Estimate the performanceofSolar Photovoltaic Panel	PO1,PO2, PO4, PO9, PO10
CO5	Identify the microstructure of the ferrous and Non-ferrous metals	PO1,PO2, PO4, PO9, PO10
CO6	Examine the hardenability of alloys using Jominy end quench test	PO1,PO2, PO4, PO9, PO10
CO7	Demonstrate various Non-destructive testing methods	PO1,PO2, PO9, PO10

THERMAL ENGINEERING LABORATORY

(i) INTERNAL COMBUSTION ENGINES

1. Valve Timing and Port Timing diagrams for IC engines.
2. Performance and Heat Balance Test on S.I and C.I engines.
3. Morse Test on Multi Cylinder Engine.
4. Retardation Test on Diesel Engine.
5. Performance and Emission Analysis on IC engine with Data Acquisition System.
6. Study on Fuel Properties (Flash point & Fire Point, Viscosity).

(ii) THERMAL SYSTEMS

7. Performance Test on Refrigeration & Air conditioning Equipments.
8. Performance Test on Two Stage Reciprocating Air Compressor and Blower.

(iii) RENEWABLE ENERGY SYSTEM

9. Performance Test on Solar Photovoltaic Panel.

METALLURGY LAB

METALLOGRAPHY

1. Metallography Specimen preparation.
2. Microstructure Examination of ferrous samples. (Mild Steel, High Carbon Steel, Stainless steel, Cast Iron)
3. Microstructure Examination of Non -Ferrous Samples. (Cu, Al, Mg and Additive Manufactured Ti6Al4V alloy).

HEAT TREATMENT STUDIES

1. Hardenability of Steels by Jominy end quench test.
2. Identification of microstructure at different cooling rates for medium carbon steel.

DEMONSTRATION OF NON-DESTRUCTIVE TESTING.

1. Liquid Penetration Test (LPT)
2. Magnetic Particle Test (MPT)
3. Ultrasonic Test (UT)

Total Periods: 45

20ME275 MANUFACTURING TECHNOLOGY LABORATORY 0 0 3 1

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Demonstrate the moulding process using appropriate tools	PO1, PO2, PO9, P10
CO2	Illustrate the turning of various features in cylindrical parts using lathe by selecting appropriate parameters	PO1, PO2, PO9, P10
CO3	Make use of milling machine to generate gears for the given specification	PO1, PO2, PO9, P10
CO4	Perform machining of various features in work blanks in Shaping and Drilling machines	PO1, PO2, PO9, P10
CO5	Demonstrate the surface finishing operations using a grinding machine	PO1, PO2, PO9, P10
CO6	Describe the production processes practiced in industries	PO6, PO2, PO9, PO10,PO12

EXERCISES

Cycle I

1. Testing of foundry sand properties
2. Preparation of core and moulds
3. Facing, step turning, knurling and taper operation
4. Manual and Computer assisted part programming using turning centres.
5. Grooving, drilling, and external threading

Cycle II

1. Shaping of a step block using Shaping machine
2. Machining of a spur gear using Universal Milling machine
3. Drilling, tapping and reaming of holes using Radial Drilling machine
4. Machining of a Helical worm gear using Gear Hobbing machine
5. Grinding of block using Surface Grinding machine
6. Grinding of a single point cutting tool using Tool and Cutter grinder
7. Manual and Computer assisted part programming using milling centres

Cycle III

1. Industrial visit for about 8 hours duration to have an exposure on manufacturing.

Total Periods: 45

20ME276 COMPUTER AIDED MODELING AND3D PRINTING LABORATORY 0 0 3 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Apply parametric modeling techniques to represent engineering systems	PO1, PO5, PO9, PO10, PO12
CO2	Build 3D models of engineering components and translate into 2D drawings	PO1, PO5, PO9, PO10, PO12
CO3	Import and export CAD neutral files like IGES, STEM, DXF	PO1, PO5, PO9, PO10, PO12
CO4	Convert geometric data into machine readable file suitable for additive manufacturing	PO1, PO5, PO9, PO10, PO12
CO5	Build prototype models using 3D printing machine from cad models	PO1, PO2, PO5, PO9, PO10, PO12

I. MODELING

1. Sketcher-line, Rectangle, Circle, Polygon etc.,
2. Solid modeling -Extrude, Revolve, Sweep, loft etc.,
3. Surface modeling -Extrude, Sweep, Trim etc.,
4. Feature manipulation - Copy, Edit, Pattern, Suppress, History operations etc.
5. Assembly-Constraints, Exploded Views, Interference check
6. Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.
7. CAD data Exchange formats- IGES, PDES, PARASOLID, DXF and STL
8. 3D modeling of machine elements.

II. 3D PRINTING

1. Generating STL files from the CAD Models and working on STL files.
2. Part orientation, support and Tool path generation.
3. Build-time calculation, amount of model and support material consumption.

Total Periods: 45

20ME210 KINEMATICS OF MACHINERY 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Summarize the inversions of basic engineering mechanisms	PO1, PO5
CO2	Construct velocity and acceleration polygons to identify the kinematics of engineering mechanisms.	PO1, PO2
CO3	Select operational parameters of belt and rope drives for the given applications.	PO1, PO2
CO4	Determine the operational parameters of gears and gear trains to accomplish desired kinematics in the output shaft.	PO1, PO2
CO5	Construct cam profiles to attain desired kinematics in followers.	PO1, PO2, PO10

BASICS OF MECHANISMS **6**

Terminology and Definitions: Mechanism and machines - rigid body, resistance body, link, kinematic pair - Types of motion - Degrees of freedom - Grashoff's Law - classification of kinematic pairs - kinematic chain, linkage, Mechanical Advantage - Kinematic inversion of four bar mechanism- Single, Double slider crank Chain and its Computer aided Simulations.

KINEMATICS **12**

Displacement, velocity and acceleration in simple mechanisms - Graphical Method: Velocity and Acceleration Polygons - Acceleration analysis: Klein's Construction, Coriolis Acceleration.

BELTS AND ROPES **8**

Introduction to belt and rope drives, types - selection of belt drive - materials used for belt and rope drives - Slip and Creep of belt - tensions in flat belt drive - angle of contact - centrifugal tension - maximum tension of belt.

GEAR TRAINS **9**

Gear Terminology - Classification of Gears - Law of Gearing-Velocity of Sliding - Forms of teeth and their comparison - Involute gears: Arc of the contact - Numbers of teeth pairs in contact - Interference and undercutting - Minimum Number of teeth to avoid interference - Gear Trains: Simple, Compound, Reverted, Epicyclic gear train.

CAMS **10**

Cam: Nomenclature and types - Follower types, and their applications - Types of follower motion: Displacement Diagrams, Graphical Construction of the cam profile.

Total Periods: 45

TEXT BOOKS

1. Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd, 5th Edition, 2019.
2. John J. Uicker, Gordon R.Pennock and Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press,4th Edition, 2014.

REFERENCES

1. Thomas Bevan, "Theory of Machines", Pearson India Education Services Pvt. Ltd, 3rd Edition, 2010.
2. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill Publishing Company Ltd, 1st Edition, 2010.
3. William Cleghorn and Nikolai Dechev, "Mechanics of Machines", Oxford University Press, 2nd Edition, 2014.

WEB REFERENCE

http://nptel.ac.in/courses/112104121/

20ME212 ELECTRIC VEHICLE TECHNOLOGY 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Summarize EV and HEV configurations along with the standards and regulations	PO1, PO12
CO2	Illustrate the various forces influencing the vehicle dynamics	PO1
CO3	Describe the specifications of batteries for electric vehicles	PO1
CO4	Outline the requirements of various charging techniques and schemes with economic considerations	PO1, PO7, PO12

INTRODUCTION TO EV AND HEV **10**

Electric Vehicle: Introduction, Need, Construction and Working - Comparison of EV and IC engine - EV configuration: Fixed and variable gearing, single and multiple motor drive, In-wheel- drives - energy storing devices - EV weight, size, force, energy and performance parameters - Standards and regulations of EV.

Hybrid EV: Introduction Configuration: series, parallel, series-parallel & complex, power flow control

VEHICLE DYNAMICS **10**

Vehicle classifications - Fundamental approaches to vehicle dynamics modelling; SAE Vehicle axis system - Forces and moments affecting vehicle - Earth fixed coordinate system - Dynamic axle loads - Equations of motion - Transmission characteristics - Vehicle performance.

ENERGY STORAGE AND CHARGING TECHNIQUES **10**

Cells, Batteries - Conversion of chemical energy to electrical energy, Battery specifications. Requirements of the charging system, charging system principles, charging sources - Alternate charging sources: wireless, solar energy - Economical considerations, fuel cell based and super capacitor-based energy storage systems.

Total Periods: 30

TEXT BOOKS

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd Edition, CRC Press, Taylor and Francis Group, 2010.
2. Thomas D. Gillespie, "Fundamentals of' Vehicle Dynamics", SAE Internationals, 1992.
3. D Smith, "Electric Vehicle Charging Station (EVCS)", 1st Edition, Kindle Edition, 2015.

REFERENCES

1. C.C Chan, K.T Chau, "Modern Electric Vehicle Technology", 1st Edition, Oxford University Press Inc., New York, 2001
2. Reza N. Jazar, "Vehicle Dynamics: Theory and Application", 3rd Edition, Springer, 2017.
3. Gerardus Blokdyk, "EV Charging Infrastructure: A Complete Guide", The Art of Service, 2020.

ONLINE REFERENCES

1. https://nptel.ac.in/courses/108/103/108103009/#
2. https://nptel.ac.in/courses/107/106/107106080/

20ME277 DESIGN FOR MANUFACTURING LABORATORY 0 0 3 1

PRE-REQUISITE

20ME271 Engineering Graphics Laboratory

20ME272 Computer Aided Engineering Graphics Laboratory

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Show the geometric features and parts through conventional representation.	PO1, PO2, PO9, PO10
CO2	Select fits and tolerances required for the parts and assembly to meet the functional requirements and represent them using appropriate symbols.	PO1, PO2, PO3, PO9, PO10
CO3	Draw the views of parts and their assemblies using conventional representation.	PO1, PO2, PO3, PO5, PO9, PO10
CO4	Interpret geometric and manufacturing data by reading the industrial drawings.	PO1, PO2, PO9, PO10, PO12

REPRESENTATION OF GEOMETRIC ELEMENTS **7**

Introduction to machine drawing, drilled, tapped holes, countersunk and counter bored holes, internal and external threads, undercuts, grooves, chamfers, fillet radii and keyways - Conventions to represent standard components and fasteners

FITS AND TOLERANCES **11**

Limits, fits and tolerances - calculation of minimum and maximum clearances and allowances - Introduction to Geometric tolerances - form and position tolerances - method of indicating geometric tolerances on part drawings, Methods of indicating the surface roughness - Interpretation of Industrial part drawings (Standard-ASME Y 14.5M-2009).

DRAFTING OF MACHINE ELEMENTS WITH GD&T NOTATIONS (using application package) **21**

Universal Coupling-Plummer Block-Swivel Bearing-Machine Vice- Protected type flanged coupling-Connecting Rod.

INDUSTRY VISIT **6**

Reading Industrial part drawings

Study on Product assembly

Industrial Practices

Total Periods: 45

REFERENCES

1. Gopalakrishnan.K.R, "Machine Drawing", Subhas Stores, Bangalore, 23rd Edition, 2017.
2. Hand book of BIS, SP: 46-2003, "Engineering Drawing Practices" for schools and colleges, New Delhi, 2003.
3. Design Data, Data Book of Engineers by PSG College of Technology, Kalaikathir Achchagam, Coimbatore, 2012.
4. ASME Y 14.5 M- 2009, "Dimensioning and Tolerancing", ASME, New York, 2009.
5. Alex Krulikowski, "Fundamentals of Geometric Dimensioning and Tolerancing", Delmar Publishers, Third Edition, New York, 2013.

20ME214 DESIGN OF MACHINE ELEMENTS 2 1 0 3

PREREQUISITE: 20ME211 Strength of Materials

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Design machine members by applying theories of failure.	PO1, PO2, PO3, PO4
CO2	Design shafts under variable loading and coupling used to join them.	PO1, PO2 PO3, PO4
CO3	Design weld joints and screwed fasteners for joining of parts.	PO1, PO2 PO3, PO4
CO4	Apply the engineering principles to design the energy storing elements.	PO1, PO2 PO3, PO4
CO5	Make use of the standard procedure to design bearings and connecting rods for industrial applications.	PO1, PO2 PO3, PO4

INTRODUCTION, STEADY AND VARIABLE STRESSES IN MACHINE MEMBER 7

Introduction to the design process - Factors influencing machine design - Selection of materials based on mechanical properties - Impact and shock loading and calculation of principal stresses for various load combinations - Eccentric loading - Factor of safety - Fatigue Strength - S-N diagram - Theories of failure - Stress concentration.

DESIGN OF SHAFTS AND COUPLINGS 10

Design of solid and hollow shaft based on strength and rigidity - Design for static and variable loading -Soderberg, Goodman and Gerber relations - Shafts subjected to combined loads; Couplings: types and uses - Design of Flange Coupling.

DESIGN OF WELDED JOINTS AND SCREWED FASTENERS 10

Welded joints: Types - strength of a welded joint - Design of parallel and transverse fillet Welded Joints - Eccentric loading; Screwed Fasteners: Nomenclature, Forms of screw threads, Types, bolts of uniform strength - Design of bolted joints under tension - Eccentric loading.

DESIGN OF ENERGY STORING ELEMENTS 8

Springs: Introduction, Types - Design of Helical and Leaf springs subject to constant loads and varying loads - Design of Concentric helical springs.

Flywheel: Introduction, Fluctuation of Speed and Energy, Design of Flywheel arms.

DESIGN OF BEARINGS AND CONNECTING ROD 10

Bearings: Introduction, Nomenclature, Types - Design of Sliding contact bearings - Selection of Rolling contact bearings; Design of Connecting rod.

Total Periods: 45

NOTE:

1. Use of P.S.G. Design data Book is permitted in the Semester Examination.

TEXTBOOKS

1. Richard G. Budynas, J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw Hill, 11th Edition, 2020.
2. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Component Design", Wiley, 7th Edition, 2019.

REFERENCES

1. Robert L. Norton, "Machine Design - An Integrated Approach", Pearson, 6th Edition 2019.
2. Spotts M.F., Shoup T.E. and L. E. Hornberge, "Design of Machine Elements", Pearson Education, 8th Edition, 2019.

WEB REFERENCE

1. http://nptel.ac.in/courses/112105124/

20ME215 THERMAL SYSTEMS AND GAS DYNAMICS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Illustrate the flow of steam through nozzles.	PO1, PO2, PO3
CO2	Estimate the performance of Steam Turbines.	PO1, PO2, PO3
CO3	Explain the isentropic flow of gases through variable area ducts.	PO1, PO2, PO3
CO4	Evaluate the flow of gases through constant area ducts.	PO1, PO2, PO3
CO5	Describe the theory of Shock Waves.	PO1, PO2, PO3

STEAM NOZZLES AND TURBINES **14**

Flow of steam through nozzles - Shapes of nozzles - Effect of friction - Critical pressure ratio - super saturated flow. Impulse and reaction turbine principles - Compounding - Velocity diagrams for simple and multistage turbines - Speed regulations - Governors.

ISENTROPIC FLOW **13**

Basic concepts - Conservation laws for mass - Momentum and energy in steady flow - Velocity of sound - Stagnation state - Critical state - Various regions of flow - Physical significance of Mach number - Characteristic Mach number - Critical Mach number - Mach cone - Effect of Mach number on compressibility - Isentropic flow through variable area ducts, nozzle and diffusers.

FLOW THROUGH CONSTANT AREA DUCTS **9**

Introduction - Governing Equations -Rayleigh line - Variation of flow properties - Maximum heat transfer - Applications - Fanno flow -Governing Equations - Fanno line - Variation of flow properties with duct length - Applications - Isothermal flow with friction.

SHOCK WAVES **9**

Flow with normal shock waves - Governing equations - Prandtl-Meyer equation - Mach number downstream of shock - Property variation across shock - Strength of shock wave - entropy change - Characteristics of flow through a Convergent - Divergent nozzle at various back pressures - Flow with oblique shock waves.

Total Periods: 45

Note: Use of Standard Steam Tables and Gas Tables are permitted in the Semester Examination.

TEXT BOOKS

1. Yahya S.M, "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion" (SI Units), New Age International (P) Limited, Revised 5th Edition, 2016.
2. Kothandaraman C.P, Domkundwar S and Domkundwar A.V., "A Course in Thermal Engineering", Dhanpat Rai& Sons, 6th Edition, 2016.

DATA BOOK

1. Yahya S.M, "Gas Tables for compressible flow", New Age International Publishers, 8th Edition, 2018.

REFERENCES

1. John J and Keith T, "Gas Dynamics". Pearson Education (P) Ltd, 3rd Edition, 2006.
2. Rathakrishnan E, "Gas Dynamics", Prentice-Hall of India, 4th Edition, 2014.
3. Ballaney P.L., "Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques", Khanna, 5th Edition, 2005.

WEB REFERENCE

1. Gas Dynamics and Jet Propulsion - http://nptel.ac.in/courses/112106166/
2. Fluid Machinery - http://nptel.ac.in/courses/112104117/

20ME216 INDUSTRIAL AUTOMATION 3 0 0 3

PREREQUISITE: 20EE261-Electrical and Electronics Engineering-Theory and lab

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Illustrate the elements ofmechatronic systems used for Industrial automation	PO1,PO2
CO2	Describe the use of varioustypes of control systems for process automation	PO1,PO2
CO3	Outline the application of mechanical actuation systems to control the processes	PO1,PO2
CO4	Summarize the applications of fluid power actuation systems for process automation	PO1,PO2

MECHATRONIC SYSTEMS **15**

Basic elements of Mechatronics systems, Open and closed loop system, Sensors Vs transducers, performance terminologies of sensors, Static and dynamic characteristics of sensors, Classification and types of sensors, Motion sensors and Light radiation sensors, mechatronic design process, Digital signals: Analogue and digital signals, A/D & D/A signal converters, Data acquisition and signal processing, sequential controllers and PLC, Microprocessors and microcontrollers, Role of electrical actuation systems in industrial automation

CONTROL SYSTEMS **15**

Terminologies: lag and steady state error, Control modes: two step mode, Proportional (P), Derivative (D), Integral (I), PID. Velocity control, Adaptive control: gain scheduled control, self-tuning and model reference adaptive system. PLC- Structure of PLC, I/O Processing, ladder programming, latching and internal relays, sequencing, timers and counters, shift registers, master and jump controls, data handling, Analogue I/O

ACTUATION SYSTEM **15**

Mechanical actuation systems: Overview on Cam mechanisms, Gears, Belt and chain drives, bearings, lead screws and ball screws

Hydraulic and Pneumatic actuation system: Block diagrams, linear actuators - Single acting, double acting and Special cylinders. Rotary actuators - Gear, Vane and Piston motors.

Control Valves: Direction Control valve: 2/2, 3/2, 4/2 and 4/3 configurations - Pressure control valve: Pressure relief valve, Pressure reducing valve- Flow control valve

Total Periods: 45

TEXT BOOKS

1. Bolton W., " Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", Pearson Education, 7th Edition, 2019.
2. Anthony Esposito, "Fluid Power with Applications", Pearson Education, 7th Edition, 2013.

REFERENCES

1. MikellP.Groover. "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, 5th Edition, New Delhi, 2019.
2. John G Webster, "Measurement Instrumentation and Sensors Handbook", Second edition, CRC Press, 2014.

WEB REFERENCE

1. https://nptel.ac.in/courses/108/105/108105088/

20ME217 MECHANICAL MEASUREMENTS AND METROLOGY 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Outline the principles and characteristics of general measurement system	PO1, PO2
CO2	Demonstrate the various sensors for measurement of strain, pressure, heat, temperature, displacement, speed, force, torque, vibration and electronic sensors.	PO1, PO2, PO5
CO3	Describe the various instruments used for measuring dimensions and forms	PO1, PO2, PO5
CO4	Outline the different concepts used in advanced metrology along with their features and applications	PO1, PO2, PO5

MEASUREMENT SYSTEM **15**

Definition, Significance of measurement, generalized measurement system, static and dynamic performance characteristics: Accuracy, precision, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response- Time delay. Calibration - methods and standards, Errors in Measurements and its types. Role of sensors in measurements. Sensors for measurement of strain, pressure, heat, **temperature, displacemen**t, speed, force, torque, vibration and electronic sensors.

METROLOGY **15**

Dimensional Metrology: Limit gauges- Taylor's principle in gauge design. Slip gauges, Mechanical- Optical- Pneumatic comparators. Linear and Angular Metrology: Devices

Gear Metrology: Terminology of screw threads, measurement of effective diameter of screw threads by 2-wire and 3-wire methods, Composite measurement and Gear roll tester

Form and Surface Metrology: Form measurements: Straightness, Flatness and roundness- dial gauge, profile projector, autocollimator. Surface texture: Roughness- Parameters- importance of surface finish - Methods of measuring surface roughness- contact method- Tomilson surface meter, Non-contact method- Optical profiler.

ADVANCED METROLOGY **15**

Lasers in metrology - Advantages of lasers - Laser scan micrometers; Laser interferometers - Applications - Straightness, Alignment; Basic concept of CMM - Types of CMM - Constructional features - Probes - Accessories - Software - Applications - Multi sensor CMMs. Machine Vision - Basic concepts of Machine Vision System - Elements - Applications - On-line and in-process monitoring in production.

Total Periods: 45

TEXT BOOKS

1. Beckwith, "Mechanical Measurements", Pearson Education India, 6th Edition, 2013.
2. Venkateshan.S.P, "Mechanical Measurements", Ane Books Pvt. Ltd, 2nd Edition, 2015.
3. John G Webster, "Measurement Instrumentation and Sensors Handbook", Second edition, CRC Press, 2014.

REFERENCES

1. Anand K Bewoor and Vinay A Kulkarni, "Metrology and Measurement", McGraw-Hill Education, 5th Edition, 2017.
2. Holman.J.P, "Experimental Methods for Engineers", Tata McGraw Hill Publications Co. Ltd., 1st Edition, 2004.
3. Horst Czichos, "Measurement, Testing and Sensor Technology", Springer, 2018.

20ME252 DYNAMICS OF MACHINERY AND LABORATORY 2 1 2 4

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Determine the forces and their effects including inertia, acting on the mechanisms.	PO1, PO2, PO9, PO10, PO12
CO2	Construct force and couple polygons to achieve balancing in machine parts.	PO1, PO2, PO4, PO9, PO10, PO12
CO3	Calculate the gyroscopic couple and its effect in ships and aeroplane.	PO1, PO2, PO4, PO9, PO10, PO12
CO4	Describe the working of speed control governors and estimate their characteristics.	PO1, PO2, PO4, PO9, PO10, PO12
CO5	Calculate the frequency of vibration in simple vibratory systems.	PO1, PO2, PO3, PO4, PO9, PO10, PO12

FORCE ANALYSIS **10**

Static force analysis of mechanisms - D'Alembert's principle - Inertia force and inertia torque - Principle of superposition - Dynamic force analysis in reciprocating engines - Equivalent dynamical system and crank shaft torque.

BALANCING **12**

Static and dynamic balancing - Balancing of rotating masses, same plane, different planes, single mass, and several masses - Balancing of reciprocating masses - Balancing of single and multi-cylinder in-line engines - Primary and secondary unbalanced forces - Partial balancing of uncoupled locomotives - Tractive force, Swaying couple and Hammer blow.

MECHANISMS FOR CONTROL **11**

Gyroscopic couple and its effect in ship and aeroplane. Governors, types - Centrifugal governors - Watt, Porter and Proell - Characteristics - Effect of friction, Calculation of equilibrium speed and range of speed, Stability, Sensitiveness, Hunting and Isochronism.

VIBRATION **12**

Basic features of vibratory systems - types - basic elements - Single degree of freedom - Equations of motion - Natural frequency - Damped free vibration - Types of damping - Damping factor - Logarithmic decrement - Critical speeds of simple shaft - Forced damped vibration - Force transmissibility and Amplitude transmissibility - Vibration isolation and Magnification factor - Torsional vibrating systems - Natural frequency of single, two and three rotor systems.

DYNAMICS OF MACHINERY AND LABORATORY

LIST OF EXERCISES

1. Preparation of cam profile and demonstration of jump speed.
2. Static and dynamic balancing of rotating masses in a test rig.

3. Plotting of pressure distribution in a journal bearing.
4. Experimentation on torque distribution using epicyclic gear train.
5. Study on characteristics of Watt, Porter, Proell&Hartnell Governors.
6. Determination of Gyroscopic Couple using Motorized Gyroscope.
7. Study of undamped free vibration of an equivalent spring mass system.

Total Periods: 75

TEXT BOOKS

1. Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd, 5th Edition, 2019.
2. John J. Uicker, Gordon R.Pennock and Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press, 4th Edition, 2014.

REFERENCES

1. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill Publishing Company Ltd, 1st Edition, 2010.
2. William Cleghorn and Nikolai Dechev, "Mechanics of Machines", Oxford University Press, 2nd Edition, 2014.
3. William T. Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan "Theory of Vibration with Application", Pearson Education, 5th Edition, 2011.

WEB REFERENCE

http://nptel.ac.in/courses/112104114/

20ME279 METROLOGY LAB AND MATERIALS TESTING LABORATORY 0 0 3 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Make use of the appropriate instruments for linear, angular and form measurements.	PO1, PO2, PO9, PO10
CO2	Demonstrate the acceptance of lots through sampling plans.	PO1, PO2, PO4, PO9, PO10
CO3	Examine the process variability through process capability analysis.	PO1, PO2, PO4, PO5, PO9, PO10
CO4	Determine the mechanical properties using destructive testing methods.	PO1, PO2, PO9, PO10
CO5	Demonstrate the surface characteristics using tribological testing.	PO1, PO2, PO9, PO10

I. METROLOGY

LIST OF EXPERIMENTS

1. Measurement using height master, height gauge and limit gauges.
2. Angular measurement using sine bar, clinometers, bevel protractor.
3. Measurement of gear profile and screw thread using optical profile projector.
4. Gear roll testing and gear concentricity testing.
5. Tool geometry measurement using Toolmaker's microscope.
6. Measurement of physical variables using LVDT/RTD/ Thermocouple and strain gauge.
7. Surface finish measurement of machined components.
8. Measurement of straightness and flatness of the surface plate using Autocollimator.
9. Sampling Analysis
10. Process Capability Analysis

II. MATERIALS TESTING LABORATORY

LIST OF EXPERIMENTS

1. Study of stress-strain characteristics of the specimen through tension test as per ASTM standard.
2. Determination of hardness of the specimen using Brinell and Rockwell hardness test as per ASTM standard.
3. Determination of toughness of the specimen using Izod and Charpy impact test as per ASTM standard.
4. Evaluation of tension and compression strength of springs.
5. Determination of dry wear and co-efficient of friction measurement using Pin on disk apparatus.
6. Demonstration on corrosion rate measurement using Salt spray chamber test in alkaline environment.

Total Hours 45

20ME219 FINITE ELEMENT METHOD 3 0 0 3

PREREQUISITES

20ME211 Strength of Materials

20MA217Transforms, Probability and Statistics

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Outline the basic steps involved in finite element method and matrix approach.	PO1, PO2, PO4
CO2	Formulate Mathematical model and numerical integration involved in Finite Element Model.	PO1, PO2, PO4
CO3	Derive the shape functions, Stiffness matrix, Strain-displacement and stress strain Matrix using different approaches.	PO1, PO2, PO4
CO4	Calculate the various stresses for 1D and 2D Problems	PO1, PO2, PO4

INTRODUCTION TO FINITE ELEMENT METHOD AND ANALYTICAL APPROACH 12

Basic Concept, Historical Background, Engineering Applications, General Steps of the FEM, Matrix Algebra, Gaussian Elimination. Variational methods of Approximation-Rayleigh-Ritz method and weighted residual approach.

ONE DIMENSIONAL FINITE ELEMENT ANALYSIS 11

Finite element modeling-Coordinates and shape functions-Potential energy approach-Galerkin approach-Assembly of stiffness matrix and load vector- Finite element equations - Quadratic shape functions-Applications to plane trusses. Steady state heat transfer - Application of one-dimensional heat transfer problems

TWO-DIMENSIONAL FINITE ELEMENT ANALYSIS 11

Concepts of Plane stress and plane strain, Finite element modeling, Constant-Strain Triangle -Potential energy approach, Galerkin approach, Element stiffness matrix and force vector, Stress Calculation, Axisymmetric formulation-Galerkin approach- Element stiffness matrix and force vector, Body forces and temperature effects, Stress calculations.

ISOPARAMETRIC FORMULATION 11

Natural coordinate systems - Isoparametric elements-shape functions for isoparametric elements - one and two dimensions - Serendipity elements - Numerical Integration.

Total Periods: 45

TEXTBOOKS

1. Logan,D.L., "A First Course in Finite Element Method", 5th Edition, Cengage Publisher, 2012.
2. Chandrupatla&Belegundu, "Introduction to Finite Elements in Engineering", 4th Edition Pearson Publisher, 2011.

REFERENCES

1. Reddy.J.N., "An Introduction to the Finite Element Method", 4th Edition, Tata McGraw-Hill, 2021.
2. Seshu, P, "Text book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
3. Rao, S.S., "The Finite Element Method in Engineering", 5th Edition, Butterworth Heinemann, 2010.

20ME220 DESIGN OF TRANSMISSION SYSTEMS 2 1 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Design of belts, wire rope and transmission chains used in power transmission systems.	PO1, PO2, PO3, PO4
CO2	Make use of standard procedures to design gears for power transmissions	PO1, PO2, PO3, PO4
CO3	Design of gear boxes for industrial and automobile applications	PO1, PO2, PO3, PO4
CO4	Apply the design principles for clutches and brakes used in automobiles and agricultural equipment.	PO1, PO2, PO3, PO4

DESIGN OF FLEXIBLE ELEMENTS **9**

Design of Flat belts and pulleys - Selection of V belts and pulleys - Selection of hoisting wire ropes and pulleys - Design of Transmission chains and Sprockets

DESIGN OF GEARS **18**

Tooth terminology - interference and tooth stresses - fatigue strength - factor of safety - gear materials - design of a spur gear pairs - parallel axis helical gears. Nomenclature of bevel and worm gears. Selection of gear material based on bending stress and contact stress - Design of bevel and worm gear pairs - Efficiency of bevel and worm gear pairs.

DESIGN OF GEAR BOXES **10**

Fundamentals - step ratio- ray diagram - kinematics layout -Design of multi-speed gearbox for machine tools.

DESIGN OF CLUTCHES AND BRAKES **8**

Internal - Expanding Rim clutches - contracting rim clutches and Band type clutches - Friction materials - Design of single and multiple plate and cone clutches - Types of brakes - Internal and External shoe brakes.

Total Periods: 45

Note: PSG Design data book may be permitted for the Autonomous Examinations

TEXTBOOKS

1. Juvinall R.C., Marshek, K.M., "Fundamentals of Machine component Design", John Wiley & Sons, 7th Edition, 2019.
2. Richard G. Budynas, Keith J. Nisbett and Shigley "Mechanical Engineering Design", Tata McGraw-Hill, 11th Edition, 2019.

REFERENCES

1. Prabhu T.J., "Design of Transmission Elements", Mani Offset, Chennai, 7th Edition, 2002.
2. Norton R.L., "Design of Machinery", 6th Edition, 2020.
3. Hamrock B.J., Jacobson B. and Schmid S.R., "Fundamentals of Machine Elements", McGraw- Hill Book Co, 3rd Edition, 2014.

WEB REFERENCE

1. http://nptel.ac.in/courses/112105125/

20ME221 HEAT TRANSFER 21 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Solve steady and unsteady state heat conduction problems for various geometries.	PO1, PO2
CO2	Compute free and forced convection heat transfer using empirical correlations.	PO1, PO2
CO3	Apply the concepts of radiation heat transfer between different surfaces.	PO1, PO2
CO4	Illustrate the concept of phase change heat transfer.	PO1, PO2
CO5	Examine the performance of heat exchanger using LMTD and NTU methods.	PO1, PO2, PO3

CONDUCTION **15**

Basic Concepts - Fourier Law of conduction - General differential equation of heat conduction - Cartesian and Cylindrical Coordinates - Conduction through plane wall, cylinders and spherical systems - Composite systems, Overall heat transfer coefficient - Critical thickness of insulation. Conduction with internal heat generation - Extended surfaces: General Equations - Types and applications - Fin efficiency, Effectiveness and performance - Unsteady heat conduction: Lumped heat analysis - Semi-infinite solids - Infinite solids - Use of Heislers Chart - Conduction Shape Factor - Introduction to Numerical Methods in heat transfer.

CONVECTION **12**

Basic concepts - Convective heat transfer coefficients - Boundary Layer concepts - Forced Convection - Dimensional analysis - External Flow and Internal Flow - Flow over bank of tubes - Free Convection - Dimensional analysis - Flow over vertical plate, horizontal plate, cylinders and spheres.

RADIATION **8**

Basic concepts - Electromagnetic Spectrum - Laws of Radiation - Black Body Radiation - Grey Body Radiation - Shape Factor Algebra - Electrical Analogy - Radiation shields - Gas Radiation.

BOILING, CONDENSATION AND HEAT EXCHANGERS **10**

Boiling - Pool boiling - Regimes of boiling - flow boiling - correlations in boiling and condensation - Condensation - Nusselt's Theory of Condensation - Film wise, drop wise condensation - Heat exchangers: Types - Overall heat transfer coefficient - Fouling factors - LMTD method of heat exchanger analysis - Effectiveness - NTU method of Heat exchanger analysis - Heat pipes - Design consideration of shell and tube heat exchanger - Compact heat exchanger.

Total Periods: 45

Note: Use of Standard Heat and Mass Transfer Data Book is permitted in the Semester Examination.

TEXT BOOKS

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 8th Edition, 2018.
2. Sachdeva R.C, "Fundamentals of Engineering Heat and Mass Transfer", New Age International, 5th Edition, 2017.

DATA BOOK

1. Kothandaraman C.P, and Subramanyan S, "Heat and Mass Transfer Data book", New Age International Publishers, 9th Edition, 2018.

REFERENCES

1. Holman J.P and SouvikBhatacharyya, "Heat Transfer", 10th Edition Tata McGraw-Hill, 2017.
2. Ozisik M.N, "Heat Transfer", McGraw-Hill Book Co., 6th Editions, 1994.
3. Yunus A Cengel, "Introduction to Thermodynamics and Heat Transfer", McGraw- Hill Education Ltd., 2nd Edition, 2010.
4. KuppanThulukkanam, "Heat Exchanger Design Handbook", CRC Press, Taylor & Francis Group, 2nd Edition, 2013.

WEB REFERENCE

1. https://nptel.ac.in/courses/103/103/103103032/
2. https://nptel.ac.in/courses/112/105/112105248/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME222 INDUSTRIAL ENGINEERING AND COST ESTIMATION 2 0 0 2

COURSE OUTCOMES

On successful completion of the course the students will be able to

CO1	Make use of method study and work measurement tools and techniques for designing work system.	PO1, PO2, PO4, PO10, PO11
CO2	Apply the principles and suitable techniques for planning and control of production with effective resource utilization.	PO1, PO2, PO4, PO11
CO3	Determine the selling price of the product using cost ladder diagram.	PO1, PO2, PO4, PO11
CO4	Estimate the cost of machining and manufacturing processes.	PO1, PO2, PO4, PO11

WORK SYSTEM DESIGN **10**

Introduction to method study: Objectives, Method study -Basic procedures- Various recording techniques -Process charts, Multiple activity charts and SIMO charts, Flow diagrams, String diagram, Cyclograph and chronocyclegraph- Principles of motion economy, Therbligs - Micro motion study and memo motion study.

Work measurement: purpose, procedure, various techniques of work measurement- Stopwatch time study- Different systems of performance rating -Time Allowance-Predetermined Motion Time System (PMTS)-Work Sampling- Simple problems involving the determination of standard time and compensation.

PRODUCTION PLANNING AND CONTROL **10**

Process planning: Approaches to process planning - Manual Process Planning- Computer Aided Process Planning (CAPP) - Retrieval and Generative approach of Computer Aided Process Planning.

Production Planning and Control: Functions - Types of production systems-Qualitative and quantitative techniques of forecasting - Simple problems in forecasting using moving average, Weighted moving average, simple exponential smoothing -Loading and scheduling-Different methods of scheduling-Expediting and dispatching, Functions and objectives of materials management, Introduction to inventory control, ABC analysis and Break-even analysis.

PRODUCTION COST ESTIMATION **10**

Elements of cost: Elements of cost, Cost ladder diagram, Problem involving elements of cost-calculating profit-selling price-catalogue price, Problems involving elements of cost -steps and procedures.

Types of estimates - Allowances in estimation - Allocation of allowances. Determination of Material cost, Labour cost and expenses -procedures, Determination of Material cost, Labour cost and expenses-simple problems-Types of cost and cost of production - Over head expenses-procedures/types, Types of cost and cost of production, Over head expenses, Cost estimate for Turning, Milling, welding and casting processes.

Total periods: 30

TEXT BOOKS

1. Panneerselvam.R, "Production and Operations Management", Prentice Hall of India Pvt. Ltd, 3rd Edition, 2012.
2. Khanna.O.P, "Industrial Engineering and Management,DhanpatRai& Sons,17th Edition,2018.
3. Sinha.B.P, "Mechanical Estimating and Costing", Tata McGraw-Hill Publishing Co, 16th Edition, 2019.

REFERENCE BOOKS

1. Khan.M.I, "Industrial Engineering", New Age International Publishers, 2nd Edition, 2009.
2. Philip.E.Hicks, "Industrial Engineering and Management: A New Perspective", McGraw-Hill, 3rd Edition, 2007.

WEB REFERENCE

1. http://nptel.ac.in/courses/112107143/
2. http://nptel.ac.in/courses/112107142/

20ME223 DIGITAL MANUFACTURING 2 0 0 2

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Outline the features of CAD/CAM for the product design and manufacturing.	PO1, PO2, PO12
CO2	Describe the part families and machine cells for flexible manufacturing systems.	PO1, PO2, PO12
CO3	Describe the various elements of digital manufacturing systems.	PO1, PO2, PO12
CO4	Summarize the architectural design and elements of IoT for smart manufacturing.	PO1, PO2, PO5,PO12

CAD/CAM **7**

Product design with CAD - Design process- Quality function deployment (QFD)-Geometric modelling - Advantages. Computer aided manufacturing: CNC machines, Classification of CNC Machines: Constructions, working principle and salient features of CNC machines. Manufacturing planning, manufacturing control - CAD/CAM integration.

COMPUTER INTEGRATED MANUFACTURING **8**

Part Families and machine groups, Parts Classification and Coding, Features of Parts Classification and Coding Systems, Cellular manufacturing, Introduction and applications of Group Technology. FMC/FMS: Types, Components of FMS, Layout configurations for FMS, FMS workstations, applications and considerations for FMS, analysis and alternate approach to FMS

INTEGRATED APPROACH FOR MANUFACTURING **10**

Digital manufacturing (DM) - definition, Operation mode and Architecture of DM, Organizational model for DM, Functional structure of DM, Information model, Operation and control model of agent-based DM, MEMS/NEMS in DM, Extreme manufacturing, Environmental protection in DM, Digital green manufacturing, DM technology in Remanufacturing engineering.

INTERNET OF THINGS **5**

Industry revolution 4.0 - Smart factories - Internet of Things Vision - IoT Strategic Research and Innovation Directions - Physical design of IOT - Logical design of IOT - IOT enabling technologies, Industrial IoT (IIoT)- Architecture and Layers of IIoT.

Total Hours: 30

TEXT BOOKS

1. Mikell P. Groover, "Automation, Production Systems and Computer-Integrated Manufacturing", 4th Edition, Pearson, 2016.
2. Zude Zhou, Shane Xie, Dejun Chen., "Fundamentals of Digital manufacturing sciences", Springer Series in Advanced Manufacturing, ISBN 978-0-85729-563-7, 2012
3. ArshdeepBahga, Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015

REFERENCES

1. Myer Kutz, "Mechanical Engineers Hand book, Design, instrumentation and Controls", Vol 2, 4th edition, wiley, 2014.
2. N.Viswanadham, Y.Narahari "Performance Modeling of Automated Manufacturing Systems" Prentice Hall, Englewood Cliffs, New Jersey, 1992.

20ME224 AI FOR MECHANICAL ENGINEERS 2 0 0 2

COURSE OUTCOMES

After completion of this course, the students will be able to

CO 1	Summarize the fundamentals of AI, the types of agents and its applications.	PO1, PO2
CO 2	Identify suitable search algorithms to solve problems using artificial intelligence techniques.	PO1, PO2, PO4, PO12
CO 3	Outline the concept of knowledge representation and predicate logic and transform the real-life information.	PO1, PO2, PO4, PO12
CO 4	Analyze the plan with the knowledge representation to solve real world problems.	PO1, PO2, PO4, PO12
CO 5	Utilize the learning model to model machines.	PO1, PO2, PO4, PO12

AI FUNDAMENTALS **6**

Introduction - Definition - Examples of AI - History of AI - Future of AI - Intelligent Agents - Rational Agent - Nature of Environment - Structure of Agents - AI Applications

PROBLEM SOLVING APPROACH TO AI PROBLEMS **8**

Problem Solving Methods - Problem Formulation - Toy Problems - Real World Problems - Search Strategies - Uninformed - Informed - Heuristics -Game Playing

KNOWLEDGE REPRESENTATION **8**

Logical Agents - Knowledge based Agents -Propositional Logic- First Order Predicate Calculus, Resolution Refutation Proofs and Answer Extraction.

PLANNING & LEARNING **8**

Planning- State Space Search-Planning Graph-Real World Example for Planning (Air Cargo Transport, Spare Tire problem, Block's world) - Learning-Supervised &Unsupervised Learning- Introduction to Reinforcement Learning.

Total Periods: 30

TEXT BOOKS

1. S. Russell and P. Norvig; Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2020.
2. Nils J Nilson, "Principles of Artificial Intelligence", Narosa Publishing House, Reprint 2002.

REFERENCES

1. Janet Finlay," An Introduction to Artificial Intelligence", CRC Press, 2020
2. Vinod Chandra S.S., AnandHareendran S., "Artificial Intelligence: Principles and Applications", PHI Learning Private Limited, Second Edition.

NPTEL:https://nptel.ac.in/courses/112/103/112103280/

20ME280 AUTOMATION LABORATORY AND HEAT TRANSFER LABORATORY 0 0 3 1

Course Outcomes:

On successful completion of the course, students will be able to

CO 1	Experiment with various types of Sensors for different applications.	PO1, PO2, PO5, PO9, PO10, PO12
CO 2	Design the Programming and logic control systems for various process automation.	PO1, PO2, PO3, PO5, PO9, PO10, PO12
CO 3	Design and Simulation of pneumatic actuating systems for industrial applications.	PO1, PO2, PO3, PO9, PO10, PO12
CO 4	Evaluate the heat transfer through conduction mode with different configurations.	PO1, PO2, PO4, PO9, PO10
CO 5	Determine the heat transfer coefficient under convection mode and verification of Stefan Boltzmann constant.	PO1, PO2, PO4, PO9, PO10
CO 6	Analyze the performance of radiation and phase change heat transfer systems.	PO1, PO2, PO4, PO9, PO10

AUTOMATION LABORATORY

CYCLE I (Sensing Systems)

1. Material Analysis and Object Setting using Proximity Sensors.
2. Object Teaching and working of PhotoElectric Sensor
3. Distance Measurement and BGS FGS Functions Using Photoelectric Sensor
4. Object setting and working of PhotoElectric Sensor using Q-Tech Technology
5. Study on Machine Vision System.

CYCLE II (Control Systems)

6. Programming PLC to operate Servo Motor powered conveyor system.
7. Programming PLC to operate Stepper and Servo Motor and interfacing it with HMI.
8. Programming PLC to operate Traffic light system and interfacing it with HMI.
9. Programming PLC to operate a three level lift system and interfacing it with HMI.
10. Programming PLC to operate a linear pick and place system and interfacing it with HMI.
11. Programming PLC to operate bottle filling system.

CYCLE III (Actuating Systems)

12. Demonstration of a circuit for controlling multiple cylinders to operate multiple cycles using cascading method.
13. Simulation of an electro pneumatic circuit to control multiple cylinders to operate Multiple cycles using cascade method.

14. Simulation of electrohydraulic circuit for controlling a double acting cylinder using 4/3 Solenoid operated DCV and proximity sensors

HEAT TRANSFER LABORATORY

LIST OF EXPERIMENTS

CONDUCTION

1. Thermal conductivity of pipe insulation using lagged pipe apparatus.
2. Thermal conductivity studies of a composite wall.

CONVECTION

3. Natural convection heat transfer for a vertical tube (external flow).
4. Forced convection heat transfer for a Horizontal tube (internal flow).
5. Heat transfer studies in a pin fin under forced convection.

RADIATION

6. Emissivity Measurement.
7. Radiation heat transfer studies using Stefan Boltzmann apparatus.

HEAT EXCHANGER

8. Effectiveness of Parallel/Counter flow heat exchanger.

BOILING AND CONDENSATION

9. Performance comparison of Heat pipes.
10. Two phase heat transfer studies using boiling heat transfer apparatus.
11. Heat Transfer studies on Filmwise and Dropwise Condensation of Vapour.

Total Periods: 45

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME281 COMPUTER AIDED ANALYSIS AND FLUID FLOW LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Build model, generate an adequate mesh for an approximate solution using software tools.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO2	Analyze structure using one-dimensional and two-dimensional elements subjected to various loading conditions.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO3	Interpret results of thermal stress distribution along plate and cylinders.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO4	Extract internal flow domains to apply boundary conditions and turbulence models for the flow field.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO5	Analyze the fluid flow characteristics of flow field passing externally over the solid structures.	PO1, PO2, PO4, PO5, PO9, PO10, PO12

I. COMPUTER AIDED ANALYSIS LABORATORY

LIST OF EXERCISES FINITE ELEMENT FORMULATION

1. Modeling and Analysis- General Steps in FEA Package.
2. Simple Modeling using ANSYS.
3. Cleanup and Mid-Surface Extraction using Hypermesh.
4. 1D, 2D and 3D Meshing Techniques using Hypermesh.

ONE DIMENSIONAL FINITE ELEMENT ANALYSIS

1. Solve Problems on 1-D Rod/Beam elements using Hypermesh
2. Solve and draw SFD, BMD for Cantilever, Simply Supported Beam with different load conditions using ANSYS.

TWO DIMENSIONAL FINITE ELEMENT ANALYSIS

1. Stress analysis of rectangular L bracket using Radioss.
2. Stress analysis of a rectangular plate with a circular hole using ANSYS.
3. Mode frequency analysis of plates.

AXISYMMETRIC DOMAIN ANALYSIS

1. Stress analysis of an axi-symmetric component using ANSYS.

HEAT TRANSFER ANALYSIS

1. Thermal stress analysis of plates using ANSYS.
2. Thermal stress analysis of cylinders using ANSYS.

II. COMPUTER AIDED FLUID FLOW LABORATORY

Introduction to Computational Fluid Dynamics

Basic Concepts - Historical Background - Engineering applications - Governing Equations - Finite Volume Method - SIMPLE algorithm & its variant - Turbulence Models. Introduction to Ansys Fluent - Preprocessor and Postprocessor - Simulation of fluid flow through a duct.

LIST OF EXERCISES

1. Fluid flow through a convergent-divergent nozzle.
2. Fluid flow over a cylindrical object.
3. Fluid flow over a vertical plate.
4. Fluid flow over a simple car model.
5. Fluid flow through a heated duct.
6. Mixing of fluids at two different temperatures in a duct.
7. Thermal analysis of an electronic board.
8. Sloshing of fluid in a tank.

Total Periods: 45

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME253 MATERIALS ENGINEERING AND METALLURGY 2 0 2 3
(Theory & Laboratory)

COURSE OUTCOMES

On successful completion of the course, the students will be able to

CO1	Describe phase diagrams and phase transformations of metals	PO1
CO2	Outline the heat-treatment processes employed to improve the metallic properties	PO1, PO12
CO3	Relate the properties of metallic and non-metallics for relevant engineering applications.	PO1, PO12
CO4	Outline the mechanism of deformation of metallic materials	PO1
CO5	Identify the microstructure of the ferrous and Non-ferrous metals	PO1, PO2, PO4, PO10
CO6	Examine the hardenability of alloys using Jominy end quench test	PO1, PO2, PO4, PO10

PHASE DIAGRAMS **11**

Hume-Rothery Rules, Solid Solutions, Gibb's phase rule, binary isomorphous alloy systems, non-equilibrium cooling, binary eutectic system, eutectoid, peritectic and monotectic reaction, phase diagrams with intermediate phases and compounds, Ion carbon equilibrium diagram - ternary phase diagrams-development of microstructures

HEAT TREATMENT **9**

TTT and CCT diagram, Principles, purpose, classification of heat treatment processes, annealing, normalizing, stress relieving, hardening, tempering. Heat treatment of non-ferrous materials

SURFACE TREATMENT

Carburizing, vacuum carburizing, nitriding, plasma nitriding, carbonitriding, flame and induction hardening

METALLIC MATERIALS **10**

Ferrous Materials - Steels - Classification of Steels - Effect of alloying on steel - Stainless steels - Maraging Steels - HSLA steels - Cast Iron and its types. Non-Ferrous Materials- Aluminium, Magnesium, Copper, Titanium - Overview of Composite Materials.

Engineering Plastics - Polyamides - Nylon 6, 66, Acetal - Homopolymer & Co-polymer, Saturated Polymers - PETP & PVTP.

Deformation Mechanisms: Dislocations - Edge and Screw - Mechanisms of plastic deformation - Slip and twinning.

METALLURGY LABORATORY

LIST OF EXPERTIMENTS

1. Metallography Specimen preparation.
2. Microstructure Examination of ferrous samples. (Mild Steel, High Carbon Steel, Stainless steel, Cast Iron)
3. Microstructure Examination of Non -Ferrous Samples. (Cu, Al, Mg and Additive Manufactured Ti6Al4V alloy).
4. Hardenability of Steels by Jominy end quench test.

TEXT BOOKS

1. Sidney H. Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill Publishing Co. Ltd., 2nd Edition, New Delhi, 2017.
2. Raghavan V., "Physical Metallurgy- Principles and Practice", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2015.

REFERENCES

1. Dieter George.E., "Mechanical Metallurgy ", McGraw Hill, 3rd Edition, New York, 2017.
2. Rajan.T.V, Sharma.C.P. and Ashok Sharma., "Heat Treatment - Principles and Techniques", Prentice Hall of India, 2nd Edition, New Delhi, 2010.
3. Vijendra Singh, "Physical Metallurgy", Standard Publishers Distributors, 1st Edition, New Delhi, Reprint, 2018.

Total Periods: 45

LIST OF EXPERIMENTS

1. Estimation of hardness of water by EDTA method.
2. Estimation of calcium and magnesium independently by EDTA method.
3. Estimation of alkalinity of water.
4. Estimation of dissolved oxygen by Winkler's method.
5. Estimation of total chloride in water.
6. Estimation of Ni in steel/Cu in brass by EDTA method.
7. Determination of strength of given hydrochloric acid by pH metry.
8. Estimation of mixture of acids by conductometric method.
9. Estimation of ferrous iron by potentiometric method.
10. Estimation of Ni using DMG by spectrophotometric method.
11. Determination of efficiency of corrosion inhibitors.
12. Anodization of aluminium and determination of thickness of anodic film.
13. Determination of molecular weight of the polymer by Ostwald Viscometry.
14. Determination of reaction rate constant of a first order reaction.
15. Analysis of a fuel by proximate analysis method.

Note: Chairpersons of the concerned board will choose the experiments

20ME254 **MECHANICAL MEASUREMENTS AND METROLOGY** **2 0 2 3**
(Theory cum Laboratory)

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Outline the principles and characteristics of general measurement system.	PO1, PO2
CO2	Demonstrate the use of sensors for measurement of various parameters.	PO1, PO2, PO5, PO9, PO10
CO3	Demonstrate the various instruments used for measuring dimensions of given components.	PO1, PO2, PO5, PO9, PO10
CO4	Demonstrate the various instruments used for measuring form and surface measurement and examine the process variability through process capability analysis.	PO1, PO2, PO3, PO5, PO9, PO10
CO5	Outline the different concepts used in advanced metrology along with construction features of the relevant equipment.	PO1, PO2, PO3

MEASUREMENT SYSTEM **12**

Definition, Significance of measurement, generalized measurement system, static and dynamic performance characteristics: Accuracy, precision, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response- Time delay. Calibration - methods and standards, Errors in Measurements and its types. Role of sensors in measurements. Sensors for measurement of strain, pressure, heat, temperature, displacement, speed, force, torque, vibration and electronic sensors.

METROLOGY **10**

Dimensional Metrology: Limit gauges- Taylor's principle in gauge design. Slip gauges, Mechanical comparators. Linear and Angular Metrology: Devices.

Gear Metrology: Terminology of screw threads, Composite measurement and Gear roll tester.

Form and Surface Metrology: Form measurements: Straightness, Flatness and roundness- dial gauge, profile projector, autocollimator. Surface texture: Roughness- Parameters- importance of surface finish - Methods of measuring surface roughness- contact method- Tomilson surface meter, Non-contact method- Optical profiler.

ADVANCED METROLOGY **8**

Lasers in metrology - Advantages of lasers - Laser scan micrometers; Laser interferometers - Applications - Straightness, Alignment; Basic concept of CMM - Types of CMM - Constructional features - Probes - Applications. Machine Vision - Basic concepts of Machine Vision System - Elements - Applications - On-line and in-process monitoring in production.

LIST OF EXPERIMENTS **30**

1. Measurement of physical variables using LVDT/RTD/ Thermocouple and strain gauge.
2. Measurement using height master, height gauge and limit gauges.
3. Angular measurement using sine bar and bevel protractor.
4. Gear roll testing and gear concentricity testing.

5. Tool geometry measurement using Toolmaker's microscope.
6. Measurement of gear profile and screw thread using optical profile projector.
7. Surface finish measurement of machined components.
8. Measurement of straightness and flatness of the surface plate using Autocollimator.
9. Process Capability Analysis.

Total Periods: 60

TEXT BOOKS

1. Beckwith, "Mechanical Measurements", Pearson Education India, 6th Edition, 2013.
2. Venkateshan.S.P, "Mechanical Measurements", Ane Books Pvt. Ltd, 2nd Edition, 2015.
3. John G Webster, "Measurement Instrumentation and Sensors Handbook", Second edition, CRC Press, 2014.

REFERENCES

1. Anand K Bewoor and Vinay A Kulkarni, "Metrology and Measurement", McGraw-Hill Education, 5th Edition, 2017.
2. Holman.J.P, "Experimental Methods for Engineers", Tata McGraw Hill Publications Co. Ltd., 1st Edition, 2004.
3. Horst Czichos, "Measurement, Testing and Sensor Technology", Springer, 2018.

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME285 THERMAL ENGINEERING & MATERIALS TESTING LABORATORY 0 0 3 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Determine the performance of IC Engines, Refrigeration and Air-Conditioning Systems	PO1, PO2, PO4, PO7, PO10
CO2	Examine the performance characteristics of Air Compressors and Blowers	PO1, PO2, PO4, PO10
CO3	Experiment with fuels to identify their properties	PO1, PO2, PO4, PO7, PO10
CO4	Estimate the performance of Solar Photovoltaic Panel	PO1, PO2, PO4, PO10
CO5	Determine the mechanical properties using destructive testing methods.	PO1, PO9, PO10
CO6	Demonstrate the surface characteristics using tribological testing.	PO1, PO9, PO10

THERMAL ENGINEERING LABORATORY

LIST OF EXPERIMENTS

(i) INTERNAL COMBUSTION ENGINES

1. Valve Timing and Port Timing diagrams for IC engines.
2. Performance and Heat Balance Test on S.I and C.I engines.
3. Morse Test on Multi Cylinder Engine.
4. Retardation Test on Diesel Engine.
5. Performance and Emission Analysis on IC engine with Data Acquisition System.
6. Study on Fuel Properties (Flash point & Fire Point, Viscosity).

(ii) THERMAL SYSTEMS

7. Performance Test on Refrigeration & Air conditioning Equipments.
8. Performance Test on Two Stage Reciprocating Air Compressor and Blower.

(iii) RENEWABLE ENERGY SYSTEM

9. Performance Test on Solar Photovoltaic Panel.

MATERIALS TESTING LABORATORY

LIST OF EXPERIMENTS

1. Study of stress-strain characteristics of the specimen through tension test as per ASTM standard.
2. Determination of hardness of the specimen using Brinell and Rockwell hardness test as per ASTM standard.
3. Determination of toughness of the specimen using Izod and Charpy impact test as per ASTM standard.
4. Evaluation of tension and compression strength of springs.
5. Determination of dry wear and co-efficient of friction measurement using Pin on disk apparatus.
6. Demonstration on corrosion rate measurement using Salt spray chamber test in alkaline environment.

Total Hours : 45

20ME286 COMPUTER AIDED ENGINEERING LABORATORY 0 0 2 1

COURSE OUTCOMES

On successful completion of the course, students will be able to

CO1	Build model, gene rate an adequate mesh for an approximate solution using software tools.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO2	Analyze structure using one-dimensional and two-dimensional elements subjected to various loading conditions.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO3	Interpret results of thermal stress distribution along plate and cylinders.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO4	Extract internal flow domains to apply boundary conditions and turbulence models for the flow field.	PO1, PO2, PO4, PO5, PO9, PO10, PO12
CO5	Analyze the fluid flow characteristics of flow field passing externally over the solid structures.	PO1, PO2, PO4, PO5, PO9, PO10, PO12

I. COMPUTER AIDED ANALYSIS LABORATORY

LIST OF EXERCISES FINITE ELEMENT FORMULATION

1. Modeling and Analysis- General Steps in FEA Package.
2. Simple Modeling using ANSYS.
3. Cleanup and Mid-Surface Extraction using Hypermesh.
4. 1D, 2D and 3D Meshing Techniques using Hypermesh.

ONE DIMENSIONAL FINITE ELEMENT ANALYSIS

1. Solve Problems on 1-D Rod/Beam elements using Hypermesh
2. Solve and draw SFD, BMD for Cantilever, Simply Supported Beam with different load conditions using ANSYS.

TWO-DIMENSIONAL FINITE ELEMENT ANALYSIS

1. Stress analysis of rectangular L bracket using Radioss.
2. Stress analysis of a rectangular plate with a circular hole using ANSYS.
3. Mode frequency analysis of plates.

AXISYMMETRIC DOMAIN ANALYSIS

1. Stress analysis of an axi-symmetric component using ANSYS.

HEAT TRANSFER ANALYSIS

1. Thermal stress analysis of plates using ANSYS.
2. Thermal stress analysis of cylinders using ANSYS.

II. COMPUTER AIDED FLUID FLOW LABORATORY

Introduction to Computational Fluid Dynamics Basic Concepts - Historical Background - Engineering applications - Governing Equations - Finite Volume Method - SIMPLE algorithm & its variant - Turbulence Models. Introduction to Ansys Fluent - Preprocessor and Postprocessor - Simulation of fluid flow through a duct.

LIST OF EXERCISES

1. Fluid flow through a convergent-divergent nozzle.
2. Fluid flow over a cylindrical object.
3. Fluid flow over a vertical plate.
4. Fluid flow over a simple car model.
5. Fluid flow through a heated duct.
6. Mixing of fluids at two different temperatures in a duct.
7. Thermal analysis of an electronic board.
8. Sloshing of fluid in a tank.

Total Periods: 45

ENLIGHTENMENT THROUGH EDUCATION
SREC

PROFESSIONAL ELECTIVES COURSES

ENLIGHTENMENT THROUGH EDUCATION
SREC

20ME2E20 FRACTURE MECHANICS 3 0 0 3

PRE–REQUISITE
16ME208 Metallurgical Engineering

COURSE OUTCOMES
On the successful completion of this course, students will able to;

CO1	Classify the various sources of crack	PO1, PO2
CO2	Determine the stress intensity factor for components	PO1, PO2, PO3
CO3	Predict material failure due to applied stresses	PO1, PO2, PO3
CO4	Determine the stress–strain and load–displacement fields around a crack tip	PO1, PO2, PO3
CO5	Analyze the propagation of fracture in components under static and dynamic conditions	PO1, PO2, PO3

INTRODUCTION AND ANALYSIS OF FRACTURE MECHANICS 15
Introduction to sources of micro and macro cracks – Fracture criterion based on stress concentration and theoretical strength – Griffith's energy. Residual stresses analysis – Crack tip Plastic Zone: Plastic zone estimation – Yielding fracture mechanics.

FRACTURE MODELS 15
Elastic-Plastic Fracture Mechanics – Path-independent integrals– J-integral fracture criterion – Crack Opening Displacement – Fatigue and Fatigue crack growth rate.

DESIGN CONCEPTS AND DYNAMICS IN FRACTURE MECHANISMS 15
Linear static fracture –Mechanics Design Concepts – Introduction – The stress criterion – Strain energy density. Dynamic Fracture: Mohr's model – Strain energy release rates – Crack branching.

Total Periods: 45

TEXTBOOKS
1. John M.Barsom and Stanley T. Rolfe "Fracture and fatigue control in structures: Applications of fracture mechanics", 3rd Edition – (ASTM manual series: MNL 41), 2000.
2. Gdoutos E.E., "Fracture Mechanics – An Introduction", Second Edition, Published by Springer, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, ISBN 1–4020–2863–6 (HB) ISBN 1–4020–3153–X (e–book).

REFERENCES
1. George Dieter, E., "Mechanical Metallurgy, "3rd Edition, Tata McGraw Hill, 2017.
2. David Broke., "Elementary Engineering Fracture Mechanics", Noordhoff, Netherland, 2005.
3. Maguid, S. A., "Engineering Fracture Mechanics", Elsevier, Geneva, 2006.

WEB REFERENCE
1. http://nptel.ac.in/courses/112106065/

20ME2E02 COMPUTER AIDED DESIGN 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will be able to;

CO 1	Outline the features of CAD and perform the transformations of geometric entities	PO1, PO2
CO 2	Illustrate the wire frame, surface and solid modeling techniques	PO1, PO2
CO 3	Describe interference and tolerance analysis to translate geometric models of assemblies	PO1, PO2
CO 4	Apply various data exchange formats for different CAD applications	PO1, PO2

CAD AND COMPUTER GRAPHICS 15

Product design and life cycle - Role of CAD in Engineering design - CAD tools - Input and Output devices - CAD system architecture - Mechanical applications and benefits of CAD. Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals - Co-ordinate systems - 2D and 3D transformations - Transformation of Geometric Models - Translation, scaling, reflection, rotation, Windowing, view port clipping, view port transformation.

GEOMETRIC MODELING AND VISUAL REALISM 15

Introduction to modeling and viewing - Wire frame modeling. Representation of curves - Hermite curve - Bezier curve - Bspline curves. Techniques for surface modeling - Surface patch - Coons and bicubic patches - Bezier and Bspline surfaces. Solid modeling techniques - Boundary representation (B-rep) and Constructive Solid Geometry (CSG). Hidden - Line, surface, solid removal algorithms, shading and coloring - computer animation.

ASSEMBLY OF PARTS & CAD STANDARDS 15

Assembly modelling – interferences of positions and orientation – tolerance analysis- mass property calculations – mechanism simulation and interference checking. Standards for computer graphics - Graphical Kernel System (GKS), standards for exchange images - Open Graphics Library (OpenGL) - Exchange of CAD data between software packages - File types - IGES, PDES, PARASOLID, ACIS, DXF Files.

Total Periods: 45

TEXT BOOKS

1. Ibrahim Zeid., “CAD/CAM - Theory and Practice”, Tata McGraw Hall Publishing Company Pvt Ltd., 2009.
2. Mikell P. Groover and Emory W. Zimmers Jr., “CAD/CAM Computer Aided Design and Manufacturing”, Prentice Hall of India., 2007.

REFERENCES

1. Foley, Wan Dam, Feiner and Hughes, “Computer Graphics: Principles & Practice”, Pearson Education, 2014.
2. William M. Neumann and Robert F. Sproul, “Principles of Computer Graphics”, McGraw Hill Book Co., 2005.
3. Radhakrishnan P and Subramaniam S ,"CAD/CAM/CIM", 3rd Edition, New Age International Publications, 2008

WEB REFERENCE

1. http://nptel.ac.in/courses/112102101/
2. https://cupdf.com/document/mikell-p-groover.html

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

20ME2E03 ENGINEERING TRIBOLOGY 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will be able to;

CO1	Describe the fundamental concepts of tribology and their parameters	PO1, PO2
CO2	Apply the principles of surface engineering for different applications of tribology	PO1, PO2, PO3
CO3	Apply the principles of friction and wear for different applications	PO1, PO2, PO3
CO4	Select proper lubricants for suitable tribological applications	PO1, PO2, PO3
CO5	Identify suitable materials for a given tribological application	PO1, PO2, PO3
CO6	Summarize the characterization tools used for nano-tribology	PO1, PO2

INTRODUCTION TO TRIBOLOGY AND SURFACE ENGINEERING 12

Historical background, practical importance, and subsequent use in the field. Surface contaminants, Effect of sliding speed on friction - Surface Treatments: Microstructural and Thermochemical Treatments, Surface Coatings: Hard Facing, Vapour Deposition Processes: PVD, CVD, PECVD. - Topography of Engineering Surfaces - Surface parameters - Geometric - Statistical parameters - Measurements - Surface contact - Types of contact - Hert'z theory of elastic contact.

FRICTION AND WEAR 11

Friction - Laws of friction - Stick - Slip phenomenon - Friction characteristics of metals and non–metals – Adhesion and Ploughing theory of friction –Ferrography - Measurement of friction.

Wear Types: Adhesive, Abrasive, Corrosive, Fatigue - Minor Forms: Fretting, Erosion, Percussion, Delamination Theory, Wear Debris Analysis, Wear Testing Methods, Wear of Metals, Ceramics, Polymers.

LUBRICATION 11

Definition & Scope. Generalized Reynold's equation – Flow and shear stress, energy equation - Mechanism of pressure development in bearings. Concept of Boundary Layer – Types of Lubricants - Selection of lubricants – Physical Properties – Lubricant additives. – Hydrodynamic – Elastohydrodynamic – Hydrostatic – Boundary and Solid lubrication.

MATERIALS AND APPLICATIONS 11

Materials for rolling element bearings – Fluid film bearings – Dry bearings. Technological Applications of tribology – Automotive Tribology. Nanotribology – Measurement Tools: Surface Force Apparatus, Scanning Tunneling Microscope, Atomic / Friction Force Microscope.

Total Periods: 45

TEXT BOOKS

1. Prasanta Sahoo, “Engineering Tribology”, PHI Learning Private Limited, 2013.
2. Gwidon W.Stachowiak and Andrew W.Batchelor., “Engineering Tribology”, 4th Edition, Elsevier Butterworth -`Heinemann Publications, 2014.

REFERENCES

1. Fuller D.D., “Theory and practice of Lubrication for Engineers”, John Wiley Sons, 2000.
2. Bowden, F.P. & Tabor, D., “The Friction and Lubrication of Solids”, Oxford University press, 2001.
3. Bharat Bhushan, “Introduction to Tribology”, 2nd Edition, John Wiley and Sons, 2013.

WEB REFERENCE

1. http://www.nptel.ac.in/courses/112102015/
2. https://nitsri.ac.in/Department/Mechanical%20Engineering/Friction_Wear_Lubrication_A_Textbook_in_Tribology_ISBN0849326850.pdf

ENLIGHTENMENT THROUGH EDUCATION ★ SREC ★

20ME2E04 MECHANICAL VIBRATIONS 3 0 0 3

PREREQUISITES

20ME215 Dynamics of Machinery
20MA208 Partial Differential Equations and Numerical Methods

COURSE OUTCOMES

On the successful completion of this course, students will able to;

CO1	Infer the causes and effects of vibration in mechanical systems	PO1, PO2
CO2	Examine the free and forced vibrations of Single degree and Multi degree freedom systems	PO1, PO2, PO3
CO3	Determine the fundamental frequency of the system using Numerical methods	PO1, PO2, PO3
CO4	Derive the mathematical model for Continuous systems using various methods	PO1, PO2
CO5	Measure and control the vibrations on mechanical system	PO1, PO2, PO3

FUNDAMENTALS OF VIBRATION 6

Basic concept of vibration – Classification, Analysis Procedure – Spring, Mass and Damping elements – Harmonic Motion and Analysis.

SINGLE AND TWO DEGREE FREEDOM SYSTEMS 16

Free vibrations – Damped vibrations – Forced Vibrations with and without damping – Response of Damped system – Duhamel's Integral. Equation of motion – Free and Forced vibration Analysis – Coordinate Couplings and Principle Coordinates.

MULTI DEGREE FREEDOM AND CONTINUOUS SYSTEMS 17

Normal mode of vibration – Flexibility Matrix and Stiffness Matrix – Eigen Values and Vectors – Determination of Natural Frequencies and Mode Shapes – Dunkerley, Rayleigh's and Holzer Method. Continuous Systems – Introduction – Longitudinal, Transverse and Torsional vibrations of Beam, String and Shaft – Rayleigh Method, Rayleigh – Ritz method.

VIBRATION MEASUREMENT AND CONTROL 6

Vibration Measuring Instruments – Transducers – Vibration Pickups – Frequency Measuring Instruments – Control of vibration and natural frequencies – Vibration Absorbers.

Total Periods: 45

TEXTBOOKS

1. Thomson W.T., "Theory of Vibration with Applications", 5th Edition, Pearson Education, 2008.
2. Rao S.S., "Mechanical Vibrations", 6thEdition, Pearson Education, 2018.

REFERENCES

1. Ramamurti V., “Mechanical Vibration Practice with Basic Theory”, Alpha Science International Ltd, 2000.
2. Graham Kelly, S and Shashidar K Kudari., “Mechanical Vibrations”, McGraw Hill Education, 2017.
3. Rao, J. S and Gupta, K., “Theory and Practice of Mechanical Vibrations”, New Age International Pvt. Ltd., 2010.

WEB REFERENCE

1. http://nptel.ac.in/courses/112103112/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E05 **MACHINE TOOL DESIGN** **3 0 0 3**

PRE–REQUISITE
20ME202 Manufacturing Technology

COURSE OUTCOMES
On the successful completion of this course, students will able to;

CO1	Describe the locating and clamping principles and relevant devices	PO1, PO2
CO2	Outline the design features of jigs used for hole making process	PO1, PO2
CO3	Summarize the fixtures used for different machining processes	PO1, PO2
CO4	Explain the operations performed using different dies in press tools	PO1, PO2
CO5	Determine the bank size for press working by considering influencing parameters	PO1, PO2, PO3

LOCATING AND CLAMPING PRINCIPLES **8**
Objectives of tool design - Functions and need of Jigs and fixtures – Principles of location – locating pins and methods – dowel pins - Principles of clamping – Mechanical, pneumatic and hydraulic actuation, Modular clamping systems- Tolerance for locating systems - Materials for locating and clamping systems.

JIGS AND FIXTURES **22**
Hole making processes - Types of drill Jigs – Components of jigs – Types of jig bushes – Jig buttons - Materials for jigs – Design of simple jigs for drilling applications.
Types of fixtures – (Milling, Lathe, Drilling, Welding and Assembly) – Components of fixtures – Materials for fixtures – Design of single and multiple component fixtures with and without tool setter- Design of fixture with rotary tables –SMED.

PRESS TOOLS **15**
Press Working Terminologies - operations – Types of presses – Simple, Compound and Progressive dies - Design of Die Blocks, Center of pressure, Strip layout, clearance on punches and dies, stock stops, guide pilot, knock out.
Bending and Drawing dies: Metal flow and factors affecting drawing - Single and double acting drawing dies. Determination of blank size – Bend allowance – Spring back- calculation of development length. Bending force
Special press working operations - Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing.

Total Periods: 45

TEXTBOOKS

1. Donaldson C., Lecain G.H. and Goold V.C., Tool Design, 4th edition, Tata McGraw-Hill Publishing Company Ltd., 2012.
2. Joshi P. H., Jigs and Fixtures, 3rd Edition, Tata McGraw–Hill Publishing Company Ltd., 2010
3. J. R. Paquin and Robert E Crowley., Die Design fundamentals , 2nd Edition, Industrial Press, 1987

REFERENCES

1. Edward G.Hoffman, "Jigs and Fixtures Design", 5th Edition, Thomson – Delmar Learning Series, 2004.
2. Cracknell.P.C and Dyson.R.W, "Handbook of Thermoplastics Injection Mould Design", 1st Edition, Chapman and Hall, 1993.

WEB REFERENCES

1. https://nptel.ac.in/courses/112/105/112105127/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E06 **COMPOSITE MATERIALS** **3 0 0 3**

COURSE OUTCOMES

On the successful completion of this course, students will be able to;

CO1	Recall the fundamental concepts, applications of composites and classify various types of composites	PO1, PO12
CO2	Outline the importance of polymer matrix composites with its processing methods	PO1, PO12
CO3	Describe various methods of processing of Metal matrix composites	PO1, PO12
CO4	Describe various methods of processing of Ceramic matrix composites	PO1, PO12
CO5	Apply micro and macro mechanics principles for designing composites	PO1, PO3, PO12
CO6	Explain the testing methods of composite materials	PO1, PO3, PO12

COMPOSITES AND ITS CLASSIFICATIONS **10**

Classification of composites on the basis of reinforcement and matrix, Classification of Reinforcement, Form and functions of reinforcement, Functions of matrices. Dispersion strengthened, particle strengthened and fiber-reinforced composites. Fibres and resin materials. Comparison with Metals and Importance over other materials, design fabrication and economic consideration.

POLYMER MATRIX COMPOSITES **11**

Polymer matrix – Thermosetting and thermoplastic resins – Processing methods Hand layup and Spray techniques, Filament winding, Pultrusion, Resin Transfer Molding, Autoclave method, Injection molding - Applications and recycling of PMC.

METAL MATRIX COMPOSITES **7**

Characteristics of MMC, Advantages and Limitations, Reinforcement types, Fabrication of MMC'S: Liquid Infiltration- Casting, Solid State Processes-Diffusion Bonding and In Situ Techniques.

CERAMIC MATRIX COMPOSITES **6**

Ceramic matrix – Classification of Ceramic Matrix composites- oxide ceramics – non oxide ceramics Reinforcement types. Fabrication of CMC's: Hot-Pressing, Infiltration, In-Situ Chemical reaction techniques, CVD and CVI, Sol-gel.

DESIGN AND TESTING OF COMPOSITES **11**

Introduction to Micro and Macro Mechanics Approach, Volume fraction – Rule of mixtures, Generalized Hooke's Law, concept of load transfer, designing with composites

Mechanical testing of composite materials – tensile, compressive, Inter laminar shear, and fracture toughness testing methods.

Total Periods: 45

TEXTBOOKS

1. Chawla K.K., "Composite materials", Springer – Verlag, 3rd Edition, 2012.
2. Kuen Y. Lin, "Composite Materials: Materials, Manufacturing, Analysis, Design and Repair", 2nd Edition, CreateSpace Independent Publishing Platform, 2015.

REFERENCES

1. Clyne T.W., and Withers P.J., "Introduction to Metal Matrix Composites", Cambridge University Press, 4th Edition, 1993.
2. Sharma S.C., "Composite Materials", Narosa Publications, 2nd Edition, 2000

WEBREFERENCE

1. https://nptel.ac.in/courses/112/104/112104229/
2. https://nptel.ac.in/courses/112/104/112104221/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E07 DESIGN FOR MANUFACTURING AND ASSEMBLY 3 0 0 3

PREREQUISITES
20ME271 Engineering Graphics laboratory
20ME277 Design for Manufacturing Laboratory

COURSE OUTCOMES
On successful completion of the course, students will be able to;

CO1	Relate the DFM guidelines for product design, manufacturing and assembly	PO1, PO2, PO3, PO4, PO6, PO12
CO2	Apply Geometric Dimensioning and Tolerancing principles for the allocation of tolerances to the part features and assembly	PO1, PO2, PO3, PO4, PO6, PO12
CO3	Group the components for assembling on selective basis by fixing tolerance ranges	PO1, PO2, PO3, PO4, PO6, PO12
CO4	Apply the datum system concept for component assembly to satisfy the functional requirements	PO1, PO2, PO3, PO4, PO6, PO12
CO5	Assign the tolerance for part features based on true positioning concept for flexible manufacturing	PO1, PO2, PO3, PO4, PO6, PO12
CO6	Outline the design modifications for the components produced in sand casting and machining process	PO1, PO2, PO3, PO4, PO6, PO12

DFMA AND TOLERANCE ANALYSIS 22
DFM approach – DFM guidelines – Material selection process – Cumulative effect of tolerances, Sure fit law, Normal law and Truncated normal law– Process capability, Process capability metrics, Cp, Cpk, Six Sigma. Geometric Dimensioning and Tolerancing – Modifiers.
Review of relationship between attainable tolerance grades and different machining process– Introduction to Tolerance Charting.
Design for assembly –Poke-Yoke– DFA index – Selective assembly: Type I and II.

DATUM SYSTEMS AND TRUE POSITION TOLERANCE 15
Degrees of freedom – Types of grouped datum systems: Group of two or three datum planes – Grouped datum plane and spigot assembling with grouped datum plane and recess – Grouped datum plane, spigot and hole assembling with grouped datum plane, recess and pin – Grouped datum plane, spigot and Tongue assembling with grouped datum plane, recess and gap.
Comparison between co-ordinate and convention method of feature location – True position tolerance – Zero true position tolerance – Virtual size concept – Floating and Fixed fasteners – Functional gauges – Paper layout gauging.

DESIGN FOR CASTING AND MACHINING 8
General design considerations for Sand Casting – Modification of castings to eliminate core – examples – Design for Machinability – Turned parts – Drilled parts – Milled parts – Redesign for manufacture.

Total Periods: 45

TEXT BOOKS

1. Alex Krulikowski, "Fundamentals of Geometric Dimensioning and Tolerancing", Delmar Publishers, 2nd Edition New York, 1997.
2. James D.Meadows, "Geometric Dimensioning and Tolerancing – Applications, Analysis and Measurement [ASME Y14.5–2009], ASME Press, 2009.

REFERENCES

1. James G.Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Publications, 2ndEdition, 1983.
2. Paul J.Drake Jr., "Dimensioning and Tolerancing Handbook", McGraw Hill, 1999.
3. Oliver R. Wade "Tolerance Control in Design and Manufacturing", Industrial Press Inc. New York Publications, 2008.

WEB REFERENCES

1. http://nptel.ac.in/courses/107103012/
2. http://nptel.ac.in/courses/112101005/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E08 METAL JOINING PROCESSES 3 0 0 3

PRE–REQUISITES

20ME202 Manufacturing Technology
20ME207 Materials Engineering
20ME274 Metallurgy Laboratory

COURSE OUTCOMES

On successful completion of the course, the student will be able to;

CO1	Define the welding and outline process requirements	PO1, PO2, PO12
CO2	Describe Arc Welding processes and the influencing parameters	PO1, PO2, PO12
CO3	Express the solid-state welding processes used for various applications	PO1, PO2, PO12
CO4	Explain the brazing and soldering processes	PO1, PO2, PO12
CO5	Summarize the types of weld tests and WPS procedures	PO1, PO2, PO12

INTRODUCTION AND CLASSIFICATION 6

Definition of welding as per AWS – Classification - Arc physics – Flux types and characteristics – Shielding gas types and characteristics – Welding symbols and positions

ARC WELDING PROCESSES 14

Power sources for Arc Welding Processes - Principle of working, Constructional arrangements, parameters, and applications of Arc Welding Processes: Shielded metal arc welding, Gas tungsten arc welding, Gas metal arc welding, Flux cored arc welding Submerged arc welding and Plasma arc welding.

SPECIAL WELDING PROCESSES 8

Gas welding - Resistance welding Processes: Spot, Seam welding, Projection Welding - Solid state welding processes: Friction welding – Friction Stir welding – Explosive welding- Laser Beam welding – Weld Cladding

BRAZING AND SOLDERING 5

Brazing: Wetting and spreading characteristics – Brazing fillers – Role of flux and characteristics –Techniques of soldering – Solders –Composition and applications.

WELDING DEFECTS AND TEST PROCEDURES 12

Types of defects as per AWS classification – Weldability concept – Cracking tests (Cold cracking tests – Hot cracking tests).Mechanical tests (tension, bend and toughness)
Welding Procedure Qualification as per Section IX of ASME B&PV – Essential variables and Non–essential variables – Procedure Qualifications – Procedure Qualification Record.

Total Periods: 45

TEXT BOOKS

1. Larry Jeffus, "Welding Principles and Applications", Delmar Cengage Learning, 7th Edition, 2011.
2. Nadkarni S.V., "Modern Arc Welding Technology", Ador Welding Ltd, 2008.

REFERENCES

1. Parmer R.S., "Welding Processes and Technology", Khanna Publishers, 8th Edition, 2005.
2. A.W.S., "Welding Handbook". Volume 1 & 2 Welding Technology, 8th Edition, 1991.
3. AWS D1.1 Structural Welding Code, API 5L, API 1104, ASME Section VIII – Division1, ASME Section IX, ASME Section II Part A and C.

WEB REFERENCES

1. http://nptel.ac.in/courses/112107090/
2. http://nptel.ac.in/courses/112107089/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E09 GREEN AND SUSTAINABLE MANUFACTURING 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, students will be able to;

CO1	Describe the need for Green Manufacturing and its basic concepts	PO1, PO7
CO2	Explain metrics for Green Manufacturing	PO1, PO2, PO7
CO3	Describe different attributes of Closed Loop Production System	PO1, PO7
CO4	Outline the basic concepts of Sustainable Manufacturing	PO1, PO7
CO5	Formulate a design strategy for Sustainable Manufacturing	PO1, PO7

INTRODUCTION TO GREEN MANUFACTURING 9

Definition, Need for green manufacturing, Three pillars of sustainability, Motivation and barriers of Green Manufacturing, Environmental impact of manufacturing: toxic chemical release, waste generation, energy consumption and carbon emissions, Strategies for Green Manufacturing.

PRINCIPLES AND METRICS FOR GREEN MANUFACTURING 9

Principles of Green Manufacturing – 5 principles, mapping 5 principles with other methods and solutions. Introduction to metrics, currently used metrics-financial metrics, metric for ecology, metric for society, multiple metrics. Life cycle assessment methodologies: impact assessment, Risk assessment.

CLOSED LOOP PRODUCTION SYSTEM FOR GREEN MANUFACTURING 9

Life cycle of production system, Economic and Ecological benefits of Closed Loop Production System, Machine Tools and Energy Consumption, LCA of Machine Tools, Process parameter optimization, Dry machining and minimum quantity lubrication, remanufacturing, Reuse, Approaches for sustainable factory design.

SUSTAINABLE MANUFACTURING FUNDAMENTALS 9

Concept and fundamentals of sustainable manufacturing: Triple bottom approach, Sustainable manufacturing tools: Environmentally conscious Quality Function Deployment, Life cycle assessment, Life cycle impact assessment methods.

DESIGN STRATEGIES AND SUSTAINABILITY MANUFACTURING PRACTICES 9

Design for disassembly, Design for recycling, Design for environment, Eco-friendly product design methods, Risk benefit assessment, Corporate social responsibility: Definition, scope, need and benefits, drivers for CSR, Standards for sustainable manufacturing – ISO 14000, PAS 2050.

Total Periods: 45

TEXT BOOKS

1. Dornfield David, Green Manufacturing-Fundamentals and Applications, Springer, 2012
2. S.Vinoth, "Sustainable Manufacturing- Concepts, Tools, Methods and Case study", Taylor & Francis, 2020

REFERENCES

1. Davim.J.Pauls, Green Manufacturing Processes and Systems, Springer, 2013
2. Davim, J.P., "Sustainable Manufacturing", John Wiley & Sons, 2010.
3. Gunther Seliger, Marwan M.K. Khraisheh and I.S. Jawahir, "Advances in Sustainable Manufacturing", Springer, 2011.
4. Surendra M. Gupta, A.J.D. (Fred) Lambert., "Environment Conscious Manufacturing", CRC Press, 2008.

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E11 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will able to;

CO1	Outline the characteristics of partial differential equations that govern the fluid flow	PO1, PO2
CO2	Apply suitable discretization technique to covert partial differential equations into algebraic equations	PO1, PO2, PO4, PO5
CO3	Formulate governing equation for the conduction problem in the given fluid flow domain	PO1, PO2, PO4, PO5
CO4	Formulate governing equation for the convection–diffusion problem in the given fluid flow domain	PO1, PO2, PO4, PO5
CO5	Apply suitable solution algorithms for the selected fluid flow domain considering boundary conditions	PO1, PO2, PO4, PO5

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 11

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent flow - Turbulence Kinetic Energy Equations – Mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

DISCRETIZATION 7

Methods of Deriving the Discretization Equations - Taylor Series formulation – Finite difference method –Control volume Formulation.

CONDUCTION 11

Finite difference and finite volume formulation of steady/transient One-Dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

CONVECTION AND DIFFUSION 9

Finite volume formulation of steady One-Dimensional convection and Diffusion problems, Central, Upwind, Hybrid and Power - Law schemes – Discretization equations for two dimensional convection and diffusion.

SOLUTION ALGORITHMS 7

SIMPLE algorithm and its variants. Turbulence models: mixing length model, two equation (k-ε) models.

Total Periods: 45

TEXT BOOKS

1. Versteeg. H. K and Malalasekera, W., An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Pearson, 2nd Edition, 2008.
2. John D. Anderson., Computational fluid dynamics basics with applications, McGraw Hill Education, Indian Edition, 2017.

REFERENCE BOOKS

1. Patankar. S.V., Numerical Heat Transfer and Fluid Flow, CRC Press, 1st Indian Edition, 2018.
2. Muralidhar, K and Sundarrajan, T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2nd Edition, 2014.
3. Pletcher, R. H., Tannehill, J. C., Anderson, D., Computational Fluid Mechanics and Heat Transfer, CRC Press, 3rd Edition, 2011.

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E10 REFRIGERATION AND AIRCONDITIONING 2 1 0 3

PRE-REQUISITES
20ME206 Thermal Engineering

COURSE OUTCOMES
On the successful completion of the course, the students will be able to;

CO1	Describe various Refrigeration Cycles	PO1, PO2
CO2	Categorize the types of refrigerants and outline the features of Refrigeration System	PO1,PO2, PO7
CO3	Discuss various psychrometric processes in Air-conditioning Systems.	PO1, PO2
CO4	Estimate the Cooling Load of Air - Conditioning Systems	PO1, PO2
CO5	Explain the functioning of Air-Conditioning System and ducts	PO1, PO2

REFRIGERATION CYCLES 10
Review of thermodynamic principles of refrigeration – Aircraft air refrigeration systems: Bell Coleman cycle and Boot strap cycle – Vapour compression refrigeration cycle – use of P-H charts – Cascade system – COP comparison – Vapor absorption refrigeration system: Ammonia Water and Lithium Bromide water systems – Steam jet refrigeration system – Thermo electric refrigeration system.

REFRIGERATION SYSTEM COMPONENTS AND BALANCING 10
Refrigerants – classifications, properties – selection of refrigerants – Ozone depletion and Montreal protocol – Alternate Refrigerants – Eco friendly Refrigerants. Compressors – reciprocating and rotary (elementary treatment) – Condensers – evaporators – cooling towers – Refrigeration plant controls – testing and charging of refrigeration units – Balancing of system components – Applications to refrigeration systems: ice plant and food storage plants.

PSYCHROMETRYAND COOLING LOAD CALCULATIONS 15
Psychrometric processes – use of psychrometric charts – Bypass factor – Grand and Room Sensible Heat Factors – requirements of comfort air conditioning – comfort charts – factors governing optimum effective temperature.
Types of loads – design of space cooling load – heat transmission through building, Solar radiation, infiltration, internal heat sources (sensible and latent) – outside air and fresh air load - Estimation of cooling load.

AIR CONDITIONING COMPONENTS 10
Air conditioning equipment – air cleaning and air filters – humidifiers – dehumidifiers – air washers – condenser – cooling tower and spray ponds – elementary treatment of duct design – air distribution system – Thermal insulation of air conditioning systems – Applications: car, industry, stores and public buildings.

Total Periods: 45

NOTE: Use of Approved Refrigeration and Air conditioning Tables and Charts are permitted for examination.

TEXT BOOKS

1. Arora R.C., "Refrigeration and Air Conditioning", PHI Learning Pvt. Ltd, New Delhi, 2010.
2. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 2011.

REFERENCES

1. Roy J.Dossat, “Principles of Refrigeration”, Pearson Education 2002.
2. Faye C. McQuiston, Jerald D. Parker, Jeffrey D. Spitler, “Heating, Ventilating, and Air Conditioning: Analysis and Design”, Wiley, 6th Edition, 2004.

DATA BOOK

1. Domkundwar V.M. and Anand V.Domkundwar, Refrigeration & Air Conditioning Data Book (SI Units), Dhandpat Rai & Co, 2014.

WEB REFERENCE

1. http://nptel.ac.in/courses/112105128/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E11 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will able to;

CO1	Outline the characteristics of partial differential equations that govern the fluid flow	PO1, PO2
CO2	Apply suitable discretization technique to covert partial differential equations into algebraic equations	PO1, PO2, PO4, PO5
CO3	Formulate governing equation for the conduction problem in the given fluid flow domain	PO1, PO2, PO4, PO5
CO4	Formulate governing equation for the convection–diffusion problem in the given fluid flow domain	PO1, PO2, PO4, PO5
CO5	Apply suitable solution algorithms for the selected fluid flow domain considering boundary conditions	PO1, PO2, PO4, PO5

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS **11**

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent flow - Turbulence Kinetic Energy Equations – Mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

DISCRETIZATION **7**

Methods of Deriving the Discretization Equations - Taylor Series formulation – Finite difference method –Control volume Formulation.

CONDUCTION **11**

Finite difference and finite volume formulation of steady/transient One-Dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems

CONVECTION AND DIFFUSION **9**

Finite volume formulation of steady One-Dimensional convection and Diffusion problems, Central, Upwind, Hybrid and Power - Law schemes – Discretization equations for two dimensional convection and diffusion.

SOLUTION ALGORITHMS **7**

SIMPLE algorithm and its variants. Turbulence models: mixing length model, two equation (k-ε) models.

Total Periods: 45

TEXT BOOKS

1. Versteeg. H. K and Malalasekera, W., An Introduction to Computational Fluid Dynamics - The Finite Volume Method, Pearson, 2nd Edition, 2008.
2. John D. Anderson., Computational fluid dynamics basics with applications, McGraw Hill Education, Indian Edition, 2017.

REFERENCE BOOKS

1. Patankar. S.V., Numerical Heat Transfer and Fluid Flow, CRC Press, 1st Indian Edition, 2018.
2. Muralidhar, K and Sundarrajan, T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2nd Edition, 2014.
3. Pletcher, R. H., Tannehill, J. C., Anderson, D., Computational Fluid Mechanics and Heat Transfer, CRC Press, 3rd Edition, 2011.

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E12 RENEWABLE ENERGY SOURCES AND SYSTEMS 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will be able to;

CO1	Explain various forms of energy sources and its effects on the environment	PO1, PO2
CO2	Demonstrate the knowledge of solar thermal and solar PV systems and analyze the performance of solar PV system	PO1, PO2, PO5, PO6
CO3	Develop a wind energy conversion system	PO1, PO2
CO4	Explain Bio gas generation and its impact on environment	PO1, PO2
CO5	Outline the methods for harvesting Ocean, Tidal and Geo thermal energy	PO1, PO2, PO5, PO6
CO6	Illustrate the Direct and Hydrogen energy conversion systems and its applications	PO1, PO2, PO5, PO6

ENERGY AND ENVIRONMENT 10

Primary energy sources – Global energy scenario – Indian energy scenario – Energy cycle of the earth – Environmental aspects of energy utilization, CO_2 emissions and Global warming – Renewable energy resources and their importance – Potential impacts of harnessing the different renewable energy resources.

SOLAR ENERGY 10

Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar water heaters and air heaters - Solar dryers - Solar cookers - Solar stills - Solar ponds - Methods of solar thermal power generation.

Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Manufacturing Process– Characteristics of cells and module - Performance parameters - Solar PV applications - Standalone- Grid connected systems.

WIND ENERGY 8

Wind data and energy estimation – Betz limit - Site selection for wind farms – Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

BIO, TIDAL, OCEAN AND GEO THERMAL ENERGY 12

Energy from Biomass and Biogas Plants – various sources – Fermentation, Pyrolysis, Gasification and Combustion, Biogas – Power generation – Design Principles of Biogas Plants – applications – Energy from wastes – Waste Burning Power Plants – Utilization of industrial and municipal wastes – Energy from the agricultural wastes.

Energy from tides and waves – Working principles of Tidal Plants and Ocean Thermal Energy Conversion (OTEC) plants – Power from Geothermal Energy – Geothermal resources – Working principle of Geothermal Power Plants.

OTHER RENEWABLE ENERGY SOURCES **5**

Direct energy conversion (Description, principle of working and basic design aspects only) – Magneto Hydrodynamic Systems (MHD) – Thermoelectric Generators – Thermionic Generators – Fuel cells – Hydrogen Conversion and Storage systems.

Total Periods: 45

TEXT BOOKS

1. Rai G. D., "Non–Conventional Energy Sources", Khanna Publishers, 5th Edition, 2017.
2. John Twidell, Tony Weir, and Anthony D. Weir, "Renewable Energy Resources", 3rd Edition, Taylor & Francis, 2015.

REFERENCES

1. Godfrey Boyle, "Renewable Energy: Power for a Sustainable Future", Oxford University Press, 3rd Edition, 2012.
2. Tiwari G. N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science, 2015.

WEB REFERENCE

1. https://nptel.ac.in/courses/108/108/108108078/
2. https://nptel.ac.in/courses/103/103/103103206/
3. https://nptel.ac.in/courses/115/105/115105127/

ENLIGHTENMENT THROUGH EDUCATION SREC

20ME2E13 ENERGY STORAGE SYSTEMS 3 0 0 3

PRE-REQUISITES

20CH201 Engineering Chemistry

COURSE OUTCOMES

On the successful completion of this course, students will be able to;

CO1	Explain various types of thermal storage systems	PO1, PO2
CO2	Identify suitable energy storage system for thermal storage applications.	PO1, PO2
CO3	Describe about various types of batteries used for electrical energy storage	PO1, PO2
CO4	Illustrate the principle and working of different types of fuel cells	PO1, PO2
CO5	Outline the various alternate energy storage technologies	PO1, PO2, PO6

THERMAL STORAGE SYSTEM 15

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications - Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

ELECTRICAL ENERGY STORAGE 12

Fundamental concept of batteries – measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide – modern batteries – zinc-Air, Nickel Hydride, Lithium Battery– Introduction to Solid state Batteries.

FUEL CELL 9

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, Merits and Demerits.

ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

Flywheel, Super capacitors, Principles and Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

Total Periods: 45

TEXTBOOKS

1. Ibrahim Dincer and Mark A. Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & Sons 2010.
2. James Larminie and Andrew Dicks, “Fuel cell systems Explained”, Wiley publications, 2003.

REFERENCES

1. Ru-shiliu, Leizhang and Xueliang Sun, “Electrochemical technologies for energy storage and conversion”, Wiley publications, 2012.
2. Alfred Rufer, “Energy Storage Systems and components”, CRC Press, 2017.

20ME2E14 **INDUSTRY 4.0** **3 0 0 3**

COURSE OUTCOMES

After successful completion of the course, students will be able to;

CO1	Describe the fundamentals of Industry 4.0 and its applications	PO1, PO12
CO2	Explain the concepts of computing and networking for IoT in Industries	PO1, PO12
CO3	Summarize the design principles and architecture of Industry 4.0.	PO1, PO12
CO4	Interpret the transformation in business model, workforce and operational processes in Industry 4.0.	PO1, PO12
CO5	Outline the applications of Industry 4.0 with case studies	PO1, PO12

OVERVIEW OF INDUSTRY 4.0 **9**

Industry 4.0: Definition, Evolution, Need for Industry 4.0, Elements and Characteristics of Industry 4.0- Importance of digital transformation- Advantages and Challenges in Industry 4.0.

INTERNET OF THINGS **9**

Basics of Networking and communication protocols- Machine-to-Machine Communications- Interoperability in IoT- Data handling and analytics – Cloud and Edge computing- IoT security risks -Pervasive sensing .

DESIGN PRINCPLES **9**

The Value Chain - Building Blocks of Industry 4.0- Design Principles of Industry 4.0- IIoT Reference Architecture: IIC Industrial Reference Architecture, Industrial Internet Architectural Framework (IIAF).

OPERATIONAL PROCESSES **9**

Digital Transformation- Transforming Operational Process- Transforming Business Models- Increasing Operational efficiency –- Transforming Workforce.

APPLICATIONS **9**

Smart Manufacturing- Intelligent Machine Applications- Autonomous systems: Artificial Intelligence-Digital twin -Virtual reality-Collaborative Virtual Factory (VF) platforms- Augmented reality Techniques - AR and VR applications.

Total Hours: 45

TEXT BOOKS

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
2. Alasdair Gilchrist “Industry 4.0, The Industrial Internet of Things”, A Press publisher 2016.
3. Klaus Schwab “The Fourth Industrial Revolution” 2016.

REFERENCE BOOKS

1. Kiran Kumar Pabbathi “Quick Start Guide to Industry 4.0 : One-stop reference guide for Industry 4.0”.
2. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, Wiley, 2014.
3. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, CRC Press, 2017.

WEB REFERENCES

1. https://www.i-scoop.eu/industry-4-0/
2. https://www.cleverism.com/industry-4-0/
3. https://onlinecourses.nptel.ac.in/noc17_cs22/

20ME2E15 MACHINE VISION SYSTEM 3 0 0 3

COURSE OUTCOMES

After successful completion of the course, students will be able to;

CO1	Interpret the basic concepts of visual perception and image digitalization	PO1, PO2
CO2	Describe the components and resolution of a cameras in machine vision system	PO1, PO2, PO5
CO3	Summarize the attributes of lighting systems and their system interfaces	PO1, PO2, PO5
CO4	Explain the techniques of image processing	PO1, PO2, PO4, PO5
CO5	Design the machine vision system for real-time applications	PO1, PO2, PO5

INTRODUCTION TO DIGITAL IMAGE 9

Digital Image -Origin-Examples-Gamma ray Imaging, X-ray Imaging, Ultra-violet band, Visible and Infrared band, Microwave band, Radio Band-Steps and Components in Digital Image Processing- Elements of Visual Perception-Light and electromagnetic spectrum-Image sensing and Acquisition-Relationship between pixels

CAMERA SYSTEM IN MACHINE VISION 9

Camera types– Field of view– Resolution: camera sensor resolution, Spatial resolution, Measurement of accuracy, Calculation of resolution, Resolution for a Line Scan Camera - Choice of the camera, Frame grabber and hardware platform– Pixel rate– Lens design - Digital and smart cameras.

LIGHTING SYSTEM IN MACHINE VISION 9

Demands on machine vision lighting – Light and light perception – Light sources for machine vision – Light Color and Part Color: Monochromatic light, white light, UV, IR and Polarized light – Light filters. Camera Computer Interface: Analog camera buses – Parallel digital camera buses– Standard PC buses – Computer buses.

IMAGE PROCESSING FUNDAMENTALS 9

Image enhancement: Gray value transformations- Image segmentation– Object Recognition - Feature extraction: Region Features– Edge extraction– Fitting and Template matching.

APPLICATIONS 9

Machine Vision in Manufacturing-Diameter Inspection of Rivets, Glue check under UV light, Pin type verification, Completeness Check of automotive component-Constraints and conditions to approach machine vision applications

Total Periods: 45

TEXT BOOKS

1. Rafael C. Gonzales and Richard E. Woods “Digital Image Processing”, 4th Edition, Pearson Publishing, 2018
2. Alexander Hornberg, “Handbook of Machine Vision”, Wiley-VCH, 2006.

REFERENCES

1. Milan Sonka, “Image Processing Analysis and Machine Vision”, Vikas Publishing House, 2007.
2. Davies E.K., “Machine Vision: Theory, Algorithms, Practicalities”, 3rd Edition, Elsevier, 2005.

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20ME2E16 **AUTOMOTIVE ELECTRONICS** **3 0 0 3**

COURSE OUTCOMES
On completion of this course, the students will be able to;

CO1	Understand the operations and controlling of various automotive subsystems	PO1, PO2
CO2	Explain the various sensors and actuators for improving fuel economy and emission control in automobiles	PO1, PO2
CO3	Establish the communication between various electronic control modules	PO1, PO2
CO4	Gain the knowledge about automotive diagnostics systems for self reporting and fault detection of automobiles	PO1, PO2, PO5
CO5	Describe the automotive instrumentation and vehicle motion control systems	PO1, PO2

AUTOMOTIVE SUBSYSTEMS AND CONTROL SYSTEMS **13**

Evolution of Automotive Electronics - Automobile Physical Configuration - Engine management system, Entertainment systems - Safety and security systems.

Electronic engine control-Electronic fuel control system, Electronic ignition system.

AUTOMOTIVE SENSORS & ACTUATORS **10**

Air flow rate sensor, Engine crankshaft angular position sensor, Engine Coolant temperature sensor, Exhaust gas oxygen sensor and Knock sensor.

Fuel injection actuator, Ignition actuator - MEMS based sensors and actuators.

AUTOMOTIVE COMMUNICATION PROTOCOLS AND DIAGNOSTICS **12**

Overview of automotive communication protocols, CAN, LIN & Flexray.

Automotive diagnostics: On board diagnostics, Off board diagnostics.

AUTOMOTIVE INSTRUMENTATION AND VEHICLE MOTION CONTROL SYSTEMS **10**

Computer based Instrumentation System, Display devices, Trip information system and Expert systems.

Configuration of Cruise control system, Digital cruise control - Antilock braking system.

Total Hours: 45

TEXT BOOKS

1. Robert Bosch GmbH, "Automotive Electrics and Automotive Electronics", John Wiley & Sons, 2008.
2. William B. Ribbens, "Understanding Automotive Electronics", Elsevier, 7th Edition, 2014.

REFERENCES

1. Tom Denton "Automobile Electrical and Electronic Systems", Elsevier Butterworth Heinemann, 3rd Edition, 2004.
2. Santini Al, "Automotive Electricity and Electronics", Cengage Learning, 2012.

WEB REFERENCE

1. http://nptel.ac.in/courses/108108031/1
2. http://nptel.ac.in/courses/112103174
3. http://nptel.ac.in/courses/112103174/3
4. http://textofvideo.nptel.ac.in/108108031

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20ME2E17 ERGONOMICS 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will be able to;

CO1	Specify and design ergonomically appropriate industrial workstations for the industrial and office work environment	PO1, PO2
CO2	Identify information-centered human factors relating to visual, illumination, controls, displays and symbols	PO1, PO2
CO3	Compare, contrast and assess human body-centred ergonomic designs for posture, material handling, repetitive motion factors, heat stress, noise and vibration	PO1, PO2, PO3
CO4	Demonstrate the ergonomic factors intrinsic in evaluating accidents, human errors and safety related incidents	PO1, PO2
CO5	Analyse key components of cost-benefit analysis in human factors and ergonomic design	PO1, PO2, PO3

OVERVIEW OF ERGONOMICS AND HUMAN FACTORS 5

Introduction:Journey, Fitting task to man their contractual structure. Domain, Philosophy and Objective, Mutual task comfort: two way dialogue, communication model, Ergonomics/ human Factors fundamentals, Physiology (work physiology) and stress

HUMAN PHYSICAL DIMENSION CONCERN 10

Human body- structure and function, anthropometrics, Anthropometry: body growth and somatotypes, Static and dynamic anthropometry, Stand Posture- erect, Anthropometry landmark: Sitting postures, Anthropometry: squatting and cross-legged postures, Anthropometric measuring techniques, Statistical treatment of data and percentile calculations

POSTURE AND MOVEMENT, BEHAVIOUR AND PERCEPTION 10

Human body- structure and function, Posture and job relation, Posture and body supportive devices, Chair characteristics, Vertical work surface, Horizontal work surface, Movement, Work Counter, Communication and cognitive issues, Psycho-social behaviour aspects, behaviour and stereotype, Information processing and perception, Cognitive aspects and mental workload, Human error and risk perception.

VISUAL ISSUES AND ENVIRONMENTS FACTORS 5

Visual performance, Visual displays, Environmental factors influencing human performance

V-ERGONOMIC DESIGN PROCESS, PERFORMANCE SUPPORT AND DESIGN INTERVENTION 10

Ergonomics design methodology, Ergonomics criteria/check while designing, Design process involving ergonomics check, Some checklists for task easiness, Occupational safety and stress at workplace in view to reduce thepotential fatigue, errors, discomforts and unsafe acts Workstation design, Furniture support, Vertical arm reach and design application possibility, Humanising design: Design and human compatibility, comfort and adaptability aspects

Total Periods: 45

TEXT BOOKS

1. Bridger, R. S., "Introduction to Ergonomics", 2nd Edition, Taylor & Francis, 2003.
2. Singh, S., "Ergonomics Interventions for Health and Productivity", Himanshu Publications, Udaipur, New Delhi, 2007

REFERENCES

1. Dul, J. and Weerdmeester, B., "Ergonomics for Beginners: A Quick Reference Guide", Taylor & Francis, 1993.
2. Green, W. S. and Jordan, P. W, "Human Factors in Product Design", Taylor & Francis, 1999.
3. Chakrabarti, D., "Indian Anthropometric Dimensions for Ergonomic Design Practice", National Institute of Design, Ahmedabad, 1997
4. Salvendy, G., "Handbook of Human Factors and Ergonomics", John Wiley & Sons, Inc., 1998

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20ME2E18 MICRO ELECTRO MECHANICAL SYSTEMS 3 0 0 3

COURSE OUTCOMES

On the successful completion of this course, students will able to;

CO1	Understand the basics of micro electromechanical systems and Microsystems	PO1, PO2
CO2	Illustrate the sensors and actuators used in Micro Electro Mechanical Systems	PO1, PO2
CO3	Identify the various types of materials used in MEMS	PO1, PO2
CO4	Classify the various types of Micro fabrication process used in MEMS	PO1, PO2
CO5	Explain the Micro System Packaging and Assembly Process	PO1, PO2

INTRODUCTION TO MEMS AND MICROSYSTEMS 8

Definition – Evolution of Micro fabrication – Characteristics of MEMS – Microsystems – Microelectronics – Miniaturization – Micro fluidics – Applications of Microsystems in various industries.

SENSORS AND ACTUATORS 14

Sensors: Electrostatic sensors, Piezo resistive sensors, piezoelectric sensors, Thermal Sensors, Optical Sensors , MEMS gyroscopes– Types and applications related to measurement of Acceleration, Pressure, Flow and Tactile in MEMS.

Actuators: Electrostatic actuators, Piezoelectric actuators, Thermal Actuators, Micro Magnetic Actuators – Inchworm technology – Case studies – Actuation using Shape Memory Alloys.

MATERIALS FOR MEMS AND MICROSYSTEMS 8

Substrates and wafers – Silicon as substrate material– Silicon Compounds – Silicon Piezo resistors – Galium Arsenide – Quartz– Piezoelectric crystals – Polymers.

MICRO–SYSTEM FABRICATION AND ASSEMBLY PROCESSES 15

Photolithography – Ion implantation – Diffusion process – Thermal oxidation – Chemical vapour deposition – Physical vapour deposition – Sputtering.

Micro manufacturing process – Etching process, Surface micromachining and LIGA Process

Micro system packaging – levels – Bonding – Interfaces – Assembly – Selection of Packaging Materials.

Total Periods: 45

TEXT BOOKS

1. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture”, Tata McGraw Hill,2002.
2. Chang Liu, "Foundations of MEMS", Pearson Education Inc, 2006.

REFERENCES

1. Nitaigour Premchand Mahalik, “MEMS” Tata McGraw Hill, 2007.
2. Mohamed Gad–el–Hak, Editor, “The MEMS Handbook”, CRC Press Baco Raton, 2000.
3. Thomas M., Adams and Richard A. Layton, “Introductory MEMS: Fabrication and Application”, Springer, 2012.

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1. http://nptel.ac.in/courses/117105082/

20ME2E19 OPERATIONS RESEARCH 3 0 0 3

COURSE OUTCOMES

On successful completion of the course, the student will be able to;

CO 1	Formulate and solve a Linear Programming Model using simplex method	PO1, PO2
CO 2	Solve Transportation and assignment Problem	PO1, PO2
CO 3	Construct and manage the project duration using PERT / CPM techniques	PO1, PO2
CO 4	Determine the sequence for n jobs 2 machines and n jobs 3 Machines	PO1, PO2
CO 5	Perform replacement analysis on individual and group replacement Models and apply game theory to solve problems with pure strategies, mixed strategies	PO1, PO2, PO3, PO4
CO 6	Solve Queuing problems and apply basic concepts of simulation Models	PO1, PO2, PO4

INTRODUCTION AND LINEAR PROGRAMMING 12

Introduction: Historical overview of operations research, fundamentals of OR, Linear Programming, formulation of L.P model– Graphical solution – Simplex algorithm.
Transportation and Assignment problems: Optimal solution by North West corner method– Least cost method – Vogel's approximation method –Optimality test – MODI method– Degeneracy–Unbalanced transportation problems Assignment problem –Hungarian method.

PROJECT MANAGEMENT AND SEQUENCING PROBLEMS 12

Network models – Basic Concepts – Construction of Networks – Project Network – CPM and PERT –Critical Path Scheduling – Crashing of Network.
Sequencing – Models with n jobs with 2 machines – Problem with n jobs with 3 machines.

DECISION MODELS 11

Game theory – Two person zero sum game – Graphic solution – Property of dominance – Algebraic solution. Replacement models – Items that deteriorate with time – When money value changes – Items that fail completely – Individual replacement and Group replacement.

QUEUEING AND SIMULATION MODELS 10

Queueing – Poisson arrivals and Exponential service times – Single channel models and Multi channel models.
Simulation – Basic concepts –Advantages and Disadvantages – Random number, Generation – Monte–Carlo Simulation – Simulation models.

Total Periods: 45

TEXT BOOKS

1. Taha H.A., “Operation Research: An Introduction”, Prentice Hall, 10th Edition, 2016.
2. Hira and Gupta, “Introduction to Operations Research”, S.Chand Ltd, 3rd Edition, 2014.

REFERENCES

1. Dharani Venkatkrishna., “Operations Research”, Keerthi Publishing House, 4th Edition, 1994.
2. Kanti Swarup, Gupta, P.K., and Manmohan, “Operations Research”, S.Chand & Sons, 2004.
3. Panneerselvan, R., “Operation Research”, Prentice Hall of India Pvt Ltd, 2nd Edition, 2009.

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1. http://nptel.ac.in/courses/112106134/1
2. http://nptel.ac.in/courses/112106131/1
3. www.nptelvideos.in/2012/12/fundamentals–of–operations–research.html

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