Regulations and Curriculum for

Bachelor of Technology (B.Tech.)

in

Electrical and Electronics Engineering

Version 2023.02

NITTE

(Deemed to be University)

(Established under Section 3 of UGC Act, 1956)
Placed under Category ‘A’ by MHRD, GoI | Accredited with ‘A+’ Grade by NAAC

Regulations and Curriculum for

Bachelor of Technology (B. Tech.)

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Electrical and Electronics Engineering

Choice Based Credit System (CBCS)

Effective from AY 2023-24

NITTE

(Deemed to be University)

(Deemed to be University under Section 3 of UGC Act, 1956)
(Placed under Category 'A' by MHRD, Govt. of India, Accredited with 'A+' Grade by NAAC)
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VISION

To build a humane society through excellence in the education and healthcare

MISSION

To develop
Nitte (Deemed to be University)
As a center of excellence imparting quality education,
Generating competent, skilled manpower to face the scientific and social challenges with a high degree of credibility, integrity,
ethical standards and social concern

Regulations and Curriculum

B. Tech. Degree Programme

Choice Based Credit System

(CBCS)

Effective from

Academic Year

2023 – 2024

Curriculum for Acquiring Professional Skills (CAPS)

With Scheme of Teaching & Examination

REGULATIONS: 2023

B.Tech. DEGREE PROGRAMME

CHOICE BASED CREDIT SYSTEM

(CBCS)

Version 2023.02

Choice Based Credit System (CBCS)

1. Choice for the selection of courses during each semester.
2. Choice in planning the academic activities by selecting desired number of courses per semester.
3. Balanced curriculum with engineering, science, humanities, and management courses.
4. Project based learning (PBL) which focusses on experiential learning.
5. Opportunities to study inter-disciplinary courses.
6. Enabling slow learners by offering important courses in all semesters.
7. Optional Summer semester.
8. Opportunity to get associated in research projects to acquire research experience.
9. Value addition with Honors / Minor credentials.

Curriculum for Acquiring Professional Skills (CAPS)

1. Practicing outcome-based education (OBE) where Courses made student-centric rather than teacher-centric.
2. Provisions for courses integrated with Lab/ PBL component.
3. Focus on experiential learning.
4. Ability enhancement and skill development courses as per National Education Policy (NEP) 2020.
5. Focus on Industry Internship and Research Internship.
6. Students to work on real world/interdisciplinary problems in major project.
7. Importance is given to creativity, innovation, and development of entrepreneurship skills.

Key Information

Program Title	Bachelor of Technology Abbreviated as B.Tech. in Electrical and Electronics Engineering
Short description	Four-year, eight semester Choice Based Credit System (CBCS) type of Undergraduate Engineering Degree Programme with English as medium of instruction.
Program Code	14ENGR07D2
Revision version	2023.02 These regulations may be modified from time to time as mandated by the policies of the University. Revisions are to be recommended by the Board of Studies for **Electrical and Electronics Engineering** and approved by the Academic Council.
Effective from	09-03-2024
Approvals	• Approved in the 54th Academic Council meeting of NITTE (Deemed to be University), held on 24.06.2023 and vide Notification of Ref: N(DU)/REG/AC-NMAMIT/2022-23/1264 dated 18.07.2023. • Approved in the 56th Academic Council meeting of NITTE (Deemed to be University), held on 23.02.2024 and vide Notification Ref: N(DU)/REG/AC-NMAMIT/2023-24/925 dated 09.03.2024.
Program offered at	NMAM Institute of Technology, Off -Campus Centre, Nitte, 574110, Karkala Taluk
Grievance and dispute resolution	All disputes arising from this set of regulations shall be addressed to the Board of Management. The decision of the Board of Management is final and binding on all parties concerned. Further, any legal disputes arising out of this set of regulations shall be limited to jurisdiction of Courts of Mangalore only.

CONTENTS

1. INTRODUCTION ... 3
2. ELIGIBILITY FOR ADMISSION ... 4
3. PROGRAM PATHS, EXIT OPTIONS AND DURATION OF THE B. TECH. PROGRAMME ... 5
4. DEGREE PROGRAMMES ... 7
5. CREDIT SYSTEM: ... 7
6. REGISTRATION ... 8
7. ADD/DROP/AUDIT OPTIONS ... 9
8. COURSE STRUCTURE: ... 10
9. ATTENDANCE REQUIREMENT: ... 19
10. WITHDRAWAL FROM THE PROGRAMME ... 19
11. EVALUATION SYSTEM ... 20
12. EVALUATION OF PERFORMANCE ... 26
13. COMMUNICATION OF GRADES ... 26
14. REQUIREMENTS OF VERTICAL PROGRESSION ... 26
15. AWARD OF CLASS ... 27
16. APPEAL FOR REVIEW OF GRADES ... 28
17. AWARD OF DEGREE ... 28
18. GRADUATION REQUIREMENTS AND CONVOCATION ... 32
19. AWARD OF PRIZES, MEDALS, & RANKS ... 32
20. CONDUCT AND DISCIPLINE ... 33

PREAMBLE

NMAM Institute of Technology (NMAMIT) was established in 1986, is located at Nitte and off-campus of NITTE (Deemed to be University), accredited by National Assessment & Accreditation Council (NAAC) with 'A+' grade. NMAMIT is recognized by the All-India Council for Technical Education (AICTE), New Delhi.

The Bachelor of Technology (B. Tech.) Programs focus on Pursuing Excellence, Empowering people, and Partnering in Community Development. Out of fourteen UG Programs i.e., Artificial Intelligence & Machine Learning (AM), Artificial Intelligence & Data Science (AD), Biotechnology (BT), Computer & Communication Engineering (CC), Computer Science & Engineering (CS), Civil Engineering (CV), Electronics & Communication Engineering (EC), Electrical & Electronics Engineering (EE), Information Science & Engineering (IS), Mechanical Engineering (ME), Robotics & Artificial Intelligence (RI), Computer Science & Engineering - Cyber Security (CB), Electronics Engineering - VLSI Design and Technology (VT), and Electronics & Communication - Advanced Communication Technology (AC), all seven eligible UG Programs i.e., BT, CS, CV, EC, EE, IS and ME are accredited by NBA, New Delhi under Tier - I category till 30th June 2025.

The curriculum is jointly approved by members of Board of Studies (BoS) and Academic Council drawn from academia, Industry, Alumni and working professionals from Industry and has been designed to integrate hands-on practical training with the concepts of theory courses to enhance the learning experience.

The Curriculum focusses students for Acquiring Professional Skills (CAPS) through rigorous theoretical training using innovations in pedagogy, experiential learning, active learning, collaborative learning, critical thinking, project planning, Project Based Learning (PBL), Ability enhancement courses for skill-building, effective communication, professional practice, creativity & innovation and developing entrepreneurial skills.

The focus of Institution is to impart Quality Education to generate competent, Skilled and Humane Manpower to face emerging Scientific, Technological, Managerial and Social Challenges with Credibility, Integrity, Ethics and Social Concern.

In the present scenario, students wish to make their own plan for bright future. However, student aspirations and the industry demands are highly diverse. Employers expect the graduates possess multi-disciplinary competency, Information and Communication Technology (ICT) and leadership skills. In this context, NMAMIT offers opportunity to the students to select the courses of their choice and helps them in grooming to have well-rounded personality and become industry ready.

The efforts have been made to make the syllabus compliant with international professional societies. As part of providing quality engineering education, at NMAMIT, Nitte has initiated the Choice Based Credit System (CBCS) into its academic curriculum. By this, the students can register courses of their choice and alter the pace of learning within the broad framework of academic course and credit requirements. CBCS allows students to plan for their academic load and alter it as they progress in learning. Students also have the option of choosing courses from a pool of courses within each classification. Ample options are given to choose interdisciplinary courses from other programs which will help the student to develop additional skills. Slow learners will also be benefitted since important courses are offered in all semesters. This arrangement helps the students to re-register the course and clear the backlog courses in the subsequent semester. Suitable provisions are made for fast learners to associate them with research activities of faculty members and contribute to research beyond the working hours.

A faculty advisor helps the student in identifying the courses to be studied in each semester based on programme requirement, course prerequisites, student's interest in various disciplines, past academic performance and courses offered by the departments.

Learning becomes more 'experiential' by carrying out labs associated with theory, mini-projects and Project Based Learning (PBL) as a part of many courses which enhances capability of students in understanding and apply the Engineering /Technology concepts to solve real life-problems. Hence students will develop the ability to apply the gained knowledge in multi-disciplinary projects and able to take up major projects based on real world problems and come up with better solutions while addressing social concerns.

REGULATIONS

COMMON TO ALL B.Tech. (CBCS) DEGREE PROGRAMMES OF NITTE (Deemed to be University)

1. INTRODUCTION

1.1 The general regulations are common to all B.Tech.(CBCS) Degree Programmes conducted at the NMAM Institute of Technology (NMAMIT), off-campus of NITTE (Deemed to be University) and shall be called "B.Tech. Regulations".

1.2 The provisions contained in this set of regulations govern the policies and procedures on the Registration of students, imparting instructions of course, conduct of the examination & evaluation, certification of student performance and all amendments related to the said Degree programme(s).

1.3 This set of Regulations, on approval by the Academic Council and Governing Council, shall supersede all the corresponding earlier sets of regulations of the B. Tech Degree program of NITTE (Deemed to be University) along with all the amendments thereto, and shall be binding on all students undergoing the Graduate Degree Programme(s) (Choice Based Credit System) conducted at the NMAMIT, Nitte with effect from its date of approval. This set of Regulations may evolve and get modified or changed through appropriate approvals from the Academic Council/ Governing Council from time to time and shall be binding on all stake holders (The Students, Faculty, Staff of Departments of NMAMIT, Nitte). The decision of the Academic Council/ Governing Council shall be final and binding.

1.4 To guarantee fairness and justice to the parties concerned in view of the periodic evolutionary refinements, any specific issues or matters of concern shall be addressed separately, by the appropriate authorities, as and when found necessary.

1.5 The Academic Council may consider any issues or matters of Concern relating to any or all the academic activities of Engineering courses for appropriate action, irrespective of whether a reference is made here in this set of Regulations or otherwise.

1.6 The program shall be called **Bachelor of Technology**, abbreviated as B.Tech. (Program Specialization).

2. ELIGIBILITY FOR ADMISSION

Sl. No	Programme	Duration	Eligibility
1	B. Tech.	4 years	Passed 10+2 examination with Physics/ Mathematics / Chemistry/ Computer Science/ Electronics/ Information Technology/ Biology/ Informatics Practices/ Biotechnology/Technical Vocational subject as per Table-1 Obtained at least 45% marks (40% marks in case of candidates belonging to reserved category) in the above subjects taken together.
2	B.Tech. (Lateral Entry to Second year)	3 years	Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in relevant branch of Engineering and Technology. (The University will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to prepare Level playing field and desired learning outcomes of the programme)

Table-1
Academic Level and Credit Framework for admission to Bachelor of Technology (B.Tech.) degree program

Sl. No.	Academic Level	Desired Entry Qualifications at different levels.	NHEQF / NSQF Level at Exit	Unified Credit Level (UCF) at Exit
1	12th Std.	-	4	4
2	First Year B.Tech. Degree	12th Completed (NHEQF /UCF level 4 completed)	5	4.5
3	Second Year B.Tech. Degree	A candidate with a Diploma in the appropriate branch of Engineering /Equivalent Vocational or Technical Program with NHEQF level 5/UCF level 4.5 completed	6	5

2.1 Qualifications from foreign countries:

Candidates with qualifications from educational institutions outside of India, may be admitted to the program(s) subject to establishment of equivalence by the university. The Program Committee will evaluate and establish the eligibility of such candidates.

3. PROGRAM PATHS, EXIT OPTIONS AND DURATION OF THE B. TECH. PROGRAMME

3.1 Program paths, exit options.

Sr. No	Academic Level	Entry Level Qualifications	Qualifications at Exit	NCrF Level
1	1st yr. of UG Degree	A candidate completing 10+2 years with Diploma of Vocation or passed 12th std. or equivalent vocational training with NCrF level 4	**UG Certificate***	4.5
2	2nd yr. of UG Degree	A candidate with Diploma in appropriate branch of Engineering/ UG Certificate/ Equivalent Vocational or Technical Program NCrF level 4.5	**UG Diploma (Engg.)***	5.0
3	3rd yr. of UG Degree	A candidate with 10+3+1/12+2/ UG Diploma (Engg.) in appropriate domain with NCrF level 5	**B. Sc (Engg.)***	5.5
4	Final yr. of UG Degree	A candidate with 3 yrs. Bachelor degree in Vocation / B.Sc. (Engg.) with NCrF level 5.5	**B. Tech (on completion of 160 credits with a minimum CGPA of 5)**	6
	Final yr. of UG Degree with Honours	A candidate with 3 yrs. Bachelor degree in Vocation / B.Sc. (Engg.) with NCrF level 5.5	**B. Tech (Honors)** 178 credits (Additional 18 credits over and above 160 credits in the same discipline	6
	Final yr. of UG Degree with a minor in (Other Discipline).	A candidate with 3 yrs. Bachelor degree in Vocation / B.Sc. (Engg.) with NCrF level 5.5	**B. Tech with Minor** 178 credits. Additional 18 credits over and above 160 credits in other disciplines	6

*** It is mandatory to earn 10 credits through internship/ Training/ Specialized courses before the award of Qualifications at Exit.**

3.2 Duration of the B. Tech. programme

(a) The B. Tech Programme shall extend over a period of total duration of 4 years for students admitted during first year of the programme.

(b) The total duration shall be 3 years for students admitted to second year under lateral entry scheme.

(c) The maximum period which a student can take to complete a fulltime academic programme is eight years / Six years for Lateral entry diploma students for B.Tech.

(d) Each year shall have the following schedule with 5 ½ days a week. Suggested break down of Academic Year into Semesters.

1.	No. of Semesters / Year	There are three semesters in an academic year. Two Main semesters (Odd, Even) followed by a summer semester. Normally the Odd Semester will be from August to December and Even Semester from January to May during a calendar year. The optional summer semester is offered during the vacation period of even semester. The summer semester is offered considering the demand for such courses of needy students, subject to the availability of time, faculty and other resources under a fast-track mode as the available instructional days during even semester vacation period are less. However, the number of instructional hours needed to cover the syllabi shall be maintained (equivalent to that in the regular semester) with a greater number of instruction hours per week. (Note: Summer semester is primarily to assist slow learners and / or failed students in the main semesters. The summer semester may be used to arrange Add-On courses for other students and / or for deputing them for practical training elsewhere)
2.	Semester Duration	Main semester (Odd, Even) each 20 Weeks; Summer Semester 8 Weeks
3.	Academic Activities (Weeks)	**ODD / EVEN Semester** Registration of Courses & Course Work (16) Examination Preparation and Examination (04) Total (20) **Summer Semester** Registration of Courses & Course Work (05) Examination Preparation and Examination (03) Total (08) **Declaration of results:** 02 weeks from the date of last examination **Inter- Semester Recess:** After each Main Semester (02) **Total Vacation:** 10 weeks (for those who do not register for summer semester) and 4 weeks (for those who register for summer semester)

(Note: In each semester, there will be provision for students for Registration of courses at the beginning, dropping of courses in the middle and withdrawal from courses towards the end, under the advice of faculty member. These facilities are expected to enhance the learning capabilities of students, minimizing their chances of failure in courses registered and ensure their better monitoring by Faculty Advisors).

A candidate shall be allowed a maximum duration of eight years from the first semester of admission to become eligible for the award of Bachelor degree.

The calendar of events in respect of the programme shall be fixed by the Institution from time to time, but preferably in line with the suggested academic calendar of the NITTE (Deemed to be University).

4. DEGREE PROGRAMMES

4.1 Undergraduate B. Tech. Degree Programmes are offered in the following disciplines by the respective programme hosting departments listed below:

i)	Biotechnology Engineering	(BT)
ii)	Computer Science & Engineering	(CS)
iii)	Computer Science & Engineering (Cyber Security)	(CB)
iv)	Civil Engineering	(CV)
v)	Electronics & Communications Engineering	(EC)
vi)	Electronics Engineering (VLSI Design and Technology)	(VT)
vii)	Electronics & Communication (Advanced Communication Technology)	(AC)
viii)	Electrical & Electronics Engineering	(EE)
ix)	Information Science & Engineering	(IS)
x)	Mechanical Engineering	(ME)
xi)	Artificial Intelligence and Machine Learning Engineering	(AM)
xii)	Computer and communication Engineering	(CC)
xiii)	Robotics and Artificial Intelligence Engineering	(RI)
xiv)	Artificial Intelligence and Data Science	(AD)
Other teaching departments are –		
i)	Chemistry	(CY)
ii)	Humanities	(HU)
iii)	Management and Social Sciences	(MG)
iv)	Mathematics	(MA)
v)	Physics	(PH)

4.2 The provisions of these regulations shall be applicable to any new discipline that may be introduced from time to time and appended to the above list.

5. CREDIT SYSTEM:

In the Credit System, the course work of students is unitized, and each unit is assigned one credit after a student completes the teaching-learning process as prescribed for that unit and is successful in its assessment.

5.1 Credit Definition: The following widely accepted definition for credit can provide the good flexibility to the students and strengthens CBCS under the University. Here, one unit of course work and its corresponding one credit (while referring to a main semester) shall be equal to:

- Four-credit theory courses shall be designed for 50 hours of the Teaching-Learning process.
- Three-credit theory courses shall be designed for 40 hours of the Teaching-Learning process.
- Two-credit theory courses shall be designed for 25 hours of the Teaching-Learning process.

- One credit theory course shall be designed for 15 hours of the Teaching-Learning process.

The above figures shall also be applicable in the case of summer semester. Other student activities which are not demanding intellectually, or which do not lend to effective assessment, like practical training, study tours, attending guest lectures shall not carry any credit.

5.2 Credit Assignment and Lower & Upper Limits for Course Credits Registration in a Semester

All courses comprise of specific Lecture/Tutorial/Practical/Project (L-T-P-J) schedule. The course credits are fixed based on the following norms.

Lecture / Tutorials / Practical:

- 1-hour Lecture per week is assigned 1.0 Credit.
- 2-hour Tutorial session per week is assigned 1.0 Credit.
- 2-hour Lab. Session/project work per week is assigned 1.0 credit.

For example,

- A theory course with L-T-P schedule of 3-2-0 hours will be assigned 4.0 credits.
- A laboratory practical course with L-T-P schedule of 0-0-2 hours will be assigned 1.0 credit.
- Calculation of Contact Hours / Week – A Typical Example
- As advised by faculty advisor, a student may register, between a minimum of 16 credits and up to a maximum of 28 credits.

The maximum number of credits a student can register during a summer semester shall be 16. However, in special cases, the student may be permitted to register additional credits with the approval of the Department Undergraduate Committee (DUGC). There is no minimum number of credits fixed for course registration during summer semester.

Example:

An LTP-C of 2-2-2-4 means 2 instructional units based on classroom lecture (L), one instructional unit of tutorial (T), one laboratory (P) based instructional unit all delivered during a calendar week and repeated for the entire duration of the semester to earn 4 credits (C) after passing the course.

6. REGISTRATION

6.1 Every student after consulting his/ her Faculty Advisor in the parent department shall register for the approved courses (core and elective) to earn credits for meeting the requirements of a degree program at the commencement of each Semester on the days fixed for such registration and notified in the academic calendar. Students who fail to register on or before the specified date will be allowed to register within one week of the last date by paying a late fee. Such courses together with their grade and credits earned will be included in the grade card issued by the University at the end of each semester, like ODD, EVEN, and summer and it forms the basis for determining the student's performance in that semester.

6.1.1 Each course will be identified by a unique Course Code of seven alpha-numerals (two alphabets followed by 5 digits). The alphabets reflect the discipline to which the course belongs. The first numeral (after the alphabet) indicates the learning level (based on prerequisites) of the course, and the rest of the three numerals indicate a running serial number. Each course also has its version to track the revisions carried out in its syllabus over time as represented by the last numerical separated by a hyphen (-). Example: EE1001-1 represents the course offered by EE Dept., Level-1, course serial number is 001 and the version is 1.

6.2 Mandatory Pre-Registration for higher semester

To facilitate proper planning of the academic activities of the Semester, the students must declare their intention to register for courses of higher semesters (3rd and above) at least two weeks before the end of the current semester choosing the courses offered by each department in the next higher semester which is displayed on the Department Notice Board at least 4 weeks before the last working day of the semester.

Registration to a higher semester is allowed only if the student fulfils the following conditions.

- Satisfied all the academic requirements to continue with the program of studies.
- Cleared all Institute, hostel, and library dues and fines, if any, of the previous semester.
- Paid all required fees of the Institute and the hostel for the current semester.
- Has not been debarred from registering on any specific grounds by the Institute.

6.3 Registering for Backlog Courses

6.3.1 Students who have not cleared a course (Theory/ Lab/ project) are shown with "F" grade. A course having an 'F' grade will be considered as a backlog and it has to be re-registered in the subsequent semesters. F-graded courses are eligible to register for the next level course (pre-requisite is met).

6.3.2 Re-registration fee will be as per the university norms existing at the time of re-registration. When a course is re-registered, the evaluation marks of that course shall be treated as canceled/ reset.

6.3.3 To provide an early opportunity for students to clear their backlog of courses, efforts will be made to offer as many courses as possible during Odd, Even and summer semesters.

7. ADD/DROP/AUDIT OPTIONS

7.1 Registration of courses

Each student shall have to register for course work at the beginning of a semester within 2 to 3 days of commencement after discussing with the course teacher and under faculty advice. The permissible course load is to be either average credits (20) or to be within the limits of minimum (16) and maximum (28) credits.

7.2 DROP-option

During a specified period in the middle of a semester student's performance in CIE is reviewed by the faculty advisor. Following a poor performance by a student, he/she can be facilitated to drop identified course(s) (up to the minimum credits specified for the semester). Such course(s) will not be mentioned in the Grade card.

Such courses are to be re-registered by these students and taken up for study at a later point in time.

7.3 Withdrawal from courses (Letter Grade "W")

During a specific period specified towards the end of the semester, a student's performance in CIE is reviewed by the faculty advisors. Following a poor performance by a student in the identified course (s) he/she is advised to withdraw from such course(s) (up to the minimum credits specified for the semester) with a mention in the Grade card (Grade "W"). Such courses to be re-registered by these students and taken up for study at a later point in time.

7.4 AUDIT-option (Letter Grade "U")

A student can register for courses for audit only, to supplement his/her knowledge and/or skills. The audit courses shall not be considered in determining the student's academic performance (SGPA and CGPA) in the semester. "U" grade is awarded to such courses and will be reflected in the grade card on satisfying the attendance requirements and CIE requirements. The candidate need not appear for SEE in such courses. However, CORE courses shall not be made available for audit.

8. COURSE STRUCTURE:

8.1 Types of courses

A "Course" is defined as a unit of learning that typically lasts one semester, led by one or more teachers, for a fixed roster of students. A course has identified course outcomes, modules/ units of study, specified teaching-learning methods and assessment schemes. A course maybe designed to include lectures, tutorial, practical, laboratory work, field work, project work, internship experiences, seminars, self-study components, online learning modules etc. in any combination.

The following types of courses are included in the B. Tech. program:

a. Humanities, Social Sciences, and Management Courses (HSMC): These are common courses for all disciplines.
b. Basic Science Courses (BSC): Physics, Chemistry and Mathematics: These are mandatory for all disciplines.
c. Engineering Science Courses (ESC): Basics of Electrical/ Electronics/ Civil/ Mechanical/ Computer Engineering, etc. These are mandatory for all disciplines.
d. Professional Core Courses (PCC): These are the professional Core Courses, relevant to the chosen specialization/ branch. The core courses shall be compulsorily studied by students, and it is mandatory to complete them to fulfill the requirements of a Program.
e. Professional Elective Courses (PEC): These are professional Electives, relevant to the chosen specialization/branch and can be chosen from the pool of courses. It shall be supportive to the discipline providing extended scope/enabling exposure to some to other discipline /domain and nurturing student proficiency skills.
f. Open Elective Courses (OEC): These are the Elective Courses from other technical areas and/ or from emerging fields. Students of other departments shall opt for these courses to fulfilling of eligibility and prerequisite mentioned in the syllabus.

g. Integrated Professional Core Courses (IPCC): It refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC shall be 04 considering L: T: P as 3:0:1 or L: T:P as 2:1:1, (where L, T and P represents credits not hours per week)

h. Holistic Education Courses (HEC): These courses are designed to look into the emotional, social, ethical and academic needs of students in an integrated learning format. It helps in the engagement of all aspects of the learner including body, mind and spirit.

i. Vocational Education Courses (VEC): These courses are designed to prepare students for jobs that are based on manual or practical activities, traditionally non-academic related to a specific trade, occupation or vocation.

j. Emerging Technology Courses (ETC): These courses are designed to teach students about developing technologies that will be available within the next five to ten years and are expected to create significant social or economic effects.

k. Programming Language Courses (PLC): These courses are designed to teach students languages that can be used to communicate with computers for developing and working on different applications.

l. University Core Courses (UCC): These are compulsory core courses with common course codes across all the disciplines.

   i. Project Work (PROJ): Provide experiential learning opportunities for students. Students are required individually, or in a small group, to select and complete a project that may include review, design, development, curation, analysis, etc. with the application of skills and knowledge relevant to the area of study. Mini-project and Project work carried out at the parent Institution, or any university / Government recognized organization without affecting the regular class work.

   ii. Internship (INT): The internship (a form of experimental learning) program is a workplace-based professional learning experience that offers supervised exposure to real-life work experience in an area related to the field of study or career interest. An internship may be undertaken at a workplace such as an industry/R&D organization/Government organization, or any other reputed organization/ institution recognized for the purpose by the University. The internship program not only helps fresh pass-outs in gaining professional know-how but also benefits corporate sectors. The internship also enhances the employability skills of the student passing out from Technical Institutions.

8.2 Mandatory Non-Credit Courses (MNC): These courses are mandatory, without the benefit of a grade or credit, passing each mandatory course is required to qualify for the award of a degree.

- Assessment of these courses is conducted in the college and will include Continuous Internal Evaluation (CIE). University Semester End Evaluation (SEE) may not be necessary for these courses.
- A minimum of 40% of the prescribed marks of CIE and SEE (If any) are required to secure a passing grade in these courses.
- The ‘PP’ grade is awarded for a Pass in the course and the ‘NP’ grade is awarded

for a Fail in the course. In case an 'NP' grade is awarded, the student has to re-register for the same course wherein he has no alternative options.

- The "PP" and "NP" grades do not carry grade points and are hence not included in the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) computations. However, such non-credit mandatory courses are required to be included in the students' performance records (transcript) with Pass or Fail (PP or NP).
- Courses that come under this category are the following.
    - Engineering Visualization, Employability Skill Development, Environmental Science, Kannada etc.

8.3 Ability Enhancement Courses (AEC): These courses are designed to help students to enhance their skills in language, communication, personality development, etc. They also promote a deeper understanding of courses like social sciences, ethics, culture, human behaviour human rights, and the law. Ability Enhancement Courses are based upon the content that leads to Knowledge enhancement.

8.4 Typical Breakdown for the B.Tech. Degree Curriculum

Sl. No.	Course Category	Credit Range	Suggested Credits
1.	Basic Science Courses (BSC)	18-23	22
2.	Engineering Science Courses (ESC)	10-15	13
3.	Emerging Technology Courses (ETC)	03-05	03
4.	Programming Language Courses (PLC)	03-05	03
5.	Professional Core Courses (PCC)	52 - 58	55
6.	Professional Elective Courses (PEC)	12-18	15
7.	Open Elective Courses (OEC)	6	6
8.	Humanities, Social Sciences and Management courses (HSMC)	09-15	12
9.	Ability Enhancement Courses (AEC)	9	9
10.	Mandatory Non-credit Courses (MNC)	Non-Credit	0
11.	Holistic Education Courses (HEC)	2	1
12.	Vocational Education Courses (VEC)	1	1
13.	Project Work (PROJ) (UCC)	10-12	10
14.	Internship (INT) (UCC)	8-12	10
15.	Note: **Student can register between 16 to 28 credits per semester**		**160**
	Total minimum Credits to be earned: 160		

The Department Undergraduate Committee (DUGC) will discuss and recommend the exact credits offered for the program for the above components, the semester-wise distribution among them, as well as the syllabi of all undergraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the Academic Council for consideration and approval.

8.5 The earned Credit Requirements for the B.Tech. Degree is 160.

Degree is awarded by prescribing the total number of credits to be earned, rather than by using the program duration, giving flexibility to a student to plan their career.

8.6 Program structure and suggested Course offerings

I/II SEMESTER													
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	MA1001-2	Matrix Algebra and Calculus	MAT	4	0	0	3	50	50	100	4
2	BSC	CY1005-1	Chemistry of Energy Storage and Display Devices	CHE	3	0	2	3	50	50	100	4
3	ESC	EE1001-2	Basic Electrical Engineering	EE	2	0	2	3	50	50	100	3
4	ESC	ME1003-2	Elements of Mechanical Engineering	ME	3	0	0	3	50	50	100	3
5	ETC	IS1101-1	Fundamentals of Cyber Security	EE	3	0	0	3	50	50	100	3
6	AEC	CS1651-1	IT Skills	Any Dept.	1	0	2	3	50	50	100	2
7	AEC	BT1651-1	Biology for Engineers	BT	1	0	0	1	50	50	100	1
8	MNC	CV1002-1	Environmental Studies	CV	1	0	0	-	50	0	50	0
9	ESC	ME1004-1	Engineering Visualization	ME	0	0	2	-	50	0	50	1
TOTAL					**18**	**0**	**8**	**19**	**450**	**350**	**800**	**21**

I/II SEMESTER												
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	MA1003-1	Differential Equations and Laplace Transforms	MAT	3	0	0	3	50	50	100	3

2	BSC	PH1006-1	Semiconductor Physics and Photonics	PHY	3	0	2	3	50	50	100	4
3	ESC	EC1001-1	Basic Electronics	EC	3	0	0	3	50	50	100	3
4	PLC	CS1004-1	Introduction to C Programming	EE	3	0	0	3	50	50	100	3
5	ESC	EC1002-2	Applied Digital Logic Design	EE	2	0	2	3	50	50	100	3
6	HSMC	HU1001-1	Technical English	HU	1	0	2	3	50	50	100	2
7	MNC	HU1002-1	Constitution of India	HU	1	0	0	-	50	0	50	0
8	BSC	MA1006-1	Mathematics with MATLAB	MAT	0	0	2	-	50	0	50	1
				TOTAL	**16**	**0**	**8**	**18**	**400**	**300**	**700**	**19**

Mandatory Internship-I*								
9	INT	UC1001-1	Internship – I	Mandatory Intra Institutional Internship of duration (80 - 90 Hours) to be completed during I & II Semesters. *The grades will be included in the IV semester grade card (Refer 11.5.2 for details)	100	--	100	2

III SEMESTER														
Sl. No.	**Course and Course code**		**Course Title**	**Teaching Dept.**	**Teaching Hours/Week**				**Examination**				**Credits**
					Theory Lecture	**Tutorial**	**Practical/Drawing**	**PBL**	**Duration in hr**	**CIE Marks**	**SEE Marks**	**Total Marks**	
					L	**T**	**P**	**J**					
1	BSC	MA2004-1	Vector Calculus & Transform Techniques	MA	3	0	0	0	03	50	50	100	3
2	IPCC	EE2003-1	Microcontroller	EE	3	0	2	0	03	50	50	100	4
3	IPCC	EE2005-1	Network Analysis	EE	3	0	2	0	03	50	50	100	4
4	PCC	EE2101-1	Analog Signal Processing	EE	3	0	0	0	03	50	50	100	3
5	PCC	EE2104-1	Generation Transmission & Distribution	EE	3	0	0	√	03	50	50	100	3
6	PCC	EE2601-1	Analog Signal Processing Laboratory	EE	0	0	2	0	03	50	50	100	1
7	HSMC	HU1004-1	Universal Human Values	Any Dept.	1	0	0	0	01	50	50	100	1
8	AEC	ME1654-1	Innovations and Design Thinking	ME	1	0	0	0	01	50	50	100	1

9	MNC	HU1003-1	Kannada (Balake / Samskrithika)	Any Dept.	1	0	0	0	-	50	-	50	0
				TOTAL	**18**	**0**	**6**	**-**	**20**	**450**	**400**	**850**	**20**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
10	MNC	MA1011-1	Bridge Course – Calculus & Laplace Transforms	MA	3	0	0	-	3	100	0	100	0

IV SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	BSC	MA2008-1	Probability Theory and Numerical Methods	MA	3	0	0	0	03	50	50	100	3
2.	IPCC	EE2002-1	Instrumentation and Measurements	EE	3	0	2	0	03	50	50	100	4
3.	IPCC	EE3002-1	Linear Control Systems	EE	3	0	2	0	03	50	50	100	4
4.	PCC	EE2102-1	Electrical Machines-I	EE	3	0	0	0	03	50	50	100	3
5.	PCC	EE2103-1	Electromagnetic Fields	EE	3	0	0	√	03	50	50	100	3
6.	PCC	EE2602-1	Electrical Machines-I Laboratory	EE	0	0	2	0	03	50	50	100	1
7.	HSMC	HU2001-1	Enhancing Self Competence	HU	2	0	0	0	03	50	50	100	2
8.	HEC	HU1005-1	Essence of Indian Culture	HU	1	0	0	0	-	50	0	50	0
9.	VEC	EEx5xx-1	Department specific Vocational Education Course	EE	0	0	2	0	03	50	50	100	1
10.	UCC	UC1001-1	Internship – I (Activity Based Internship)	Mandatory Intra Institutional Activity based Internship of 2 weeks duration (80 - 90 h) to be completed during the vacations of I & II Semesters. Lateral entry students have to complete the Internship - I during the vacation of III semester						100	-	100	2
				TOTAL	**18**	**0**	**8**	**-**	**24**	**550**	**400**	**950**	**23**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
11	MNC	MA1013-1	Bridge Course – Probability and Differential Equations	MA	3	0	0	-	3	100	0	100	0

V SEMESTER

Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week: Theory Lecture (L)	Tutorial (T)	Practical (P)	PBL (J)	Examination: Duration in hr	CIE Marks	SEE Marks	Total Marks	Credits
1	IPCC	EE2001-1	Electrical Machines -II	EE	3	0	2	0	3	50	50	100	4
2	IPCC	EE2004-1	Modern Switchgear and Protection	EE	3	0	2	0	3	50	50	100	4
3	PCC	EE3101-1	Power Electronics	EE	3	0	0	0	3	50	50	100	3
4	PCC	EE3602-1	Power Electronics Laboratory	EE	0	0	2	0	3	50	50	100	1
5	PEC	EExxxx-1	Professional Elective-I	EE	3	0	0	0	3	50	50	100	3
6	HSMC	HU1006-1	Intellectual Property Rights	Any Dept.	1	0	0	0	1	50	50	100	1
7	AEC	HU1010-1	Research Methodology	Any Dept	2	0	0	0	3	50	50	100	2
		XXx6xx-2	Program Specific Ability Enhancement Course	EE	1	0	2	0					
8	AEC	HU1007-1	Social Connect & Responsibility	Any Dept.	1	0	0	0	1	50	50	100	1
9	AEC	UM1003-1	Employability Skill Development	EE	1	0	0	0	-	50	0	50	1
				TOTAL	**17/16**	**0**	**8**	**-**	**20**	**450**	**400**	**850**	**20**

VI SEMESTER

Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week: Theory Lecture (L)	Tutorial (T)	Practical (P)	PBL (J)	Examination: Duration in hr	CIE Marks	SEE Marks	Total Marks	Credits
1.	IPCC	EE3003-1	Signal Analysis and Processing	EE	3	0	2	0	3	50	50	100	4
2.	PCC	EE3102-1	Power System Analysis and Stability	EE	3	0	0	0	3	50	50	100	3
3.	PCC	EE3603-1	Power System Analysis and Stability Laboratory	EE	0	0	2	0	3	50	50	100	1

4.	PEC	EEx2xx-1	Professional Elective – II (Group -I)	EE	3	0	0	0	3	50	50	100	3
5.	PEC	EEx3xx-1	Professional Elective - III (Group-II)	EE	3	0	0	0	3	50	50	100	3
6.	OEC	XXX5XX-1	Open Elective –I	Any Dept.	3	0	0	0	3	50	50	100	3
7.	HSMC	MG1003-1	Management & Entrepreneurship	Any Dept.	3	0	0	0	3	50	50	100	3
8.	AEC	HU1008-1	Life Skills for Engineers	HU	1	0	0	0	1	50	50	100	1
				TOTAL	**19**	0	**4**	**-**	**22**	**400**	**400**	**800**	**21**

VII SEMESTER														
Sl. No.	**Course and Course code**		**Course Title**	**Teaching Dept.**	**Teaching Hours/Week**				**Examination**				**Credits**
					Theory Lecture	**Tutorial**	**Practical**	**Self-Study**	**Duration in hr**	**CIE Marks**	**SEE Marks**	**Total Marks**	
					L	**T**	**P**	**S**					
1.	IPCC	EE3001-1	Industrial Drives and Applications	EE	3	0	2	0	3	50	50	100	4
2.	PCC	EE3601-1	High Voltage Engineering Laboratory	EE	0	1	1	0	3	50	50	100	1
3.	PEC	EEx2xx-1	Professional Elective – IV (Group-I)	EE	3	0	0	0	3	50	50	100	3
4.	PEC	EEx3xx-1	Professional Elective – V (Group-II)	EE	3	0	0	0	3	50	50	100	3
5.	OEC	XXX5XX-1	Open Elective –II	Any Dept.	3	0	0	0	3	50	50	100	3
6.	HSMC	MG1002-1	Financial Management	Any Dept.	3	0	0	0	3	50	50	100	3
7.	HEC	HU1009-1	Indian Knowledge Systems	HU	1	0	0	0	-	50	0	50	1
8.	UCC	UC3001-1	Major Project Phase- I	EE	-	-	4	-	-	100	0	100	2
				TOTAL	**16**	**1**	**7**	**-**	**18**	**450**	**300**	**750**	**20**

VIII SEMESTER												
Sl. No.	**Course and Course code**		**Course Title**	**Teaching Hours/Week**			**Examination**					**Credits**
				Theory Lecture	**Tutorial**	**Project/ Self study**	**Duration in hr**	**CIE Marks**	**SEE Marks**	**Total Marks**		
				L	**T**	**J/S**						
1.	UCC	UC2001-1	Internship- II (Societal internship and Research/Industry Internship)	Mandatory Societal internship for 2 weeks (80 – 90 h) and Research Internship / Industry Internship of 6 weeks (240 – 270 h) or Research Internship / Industry Internship for a total of 8 weeks (320 – 360 h)to be completed in one/two stretches during the vacation periods between IV to VII semesters			3	50	50	100		8
2.	UCC	UC3002-1	Major Project Phase - II	Student should carry out project in research institute/industry/intra institute Center of Excellences. Two contact hours /week for interaction between the project guide and students.			3	100	100	200		8
TOTAL				-	-	-	**6**	**150**	**150**	**300**		**16**

8.7 Eligibility for submission of Project Work Report

8.7.1 Project work during the 8th semester shall be taken up batch-wise and report can be submitted for evaluation only on completion of a minimum of 122 credits and for Diploma lateral entry students (those who have joined the second year B.Tech.) the same is 88 credits.

8.7.2 Project work can be carried out as domain-specific /interdisciplinary under the guidance of faculty/ faculty members. They can also opt for an advanced Internship or research Internship in an Industry / Research Institution/Center of excellence.

8.7.3 Project viva-voce examination shall be conducted individually.

8.8 ELECTIVES

8.8.1 A candidate shall take electives in each semester from groups of electives, commencing from the 5th semester.

8.8.2 The minimum number of students to be registered for any Elective offered shall not be less than fifteen (15) and should not exceed forty (40).

8.8.3 A candidate shall opt for his/her choice of electives and register for the same at the beginning of each of the 5th to 7th semesters if pre-registration is not done. The candidate is permitted to opt for a change of elective within 15 days from the date of commencement of the semester as per the academic calendar of the college.

9. ATTENDANCE REQUIREMENT:

9.1 Each semester is considered as a unit and the candidate has to put in a minimum attendance of 85% in each subject with a provision of condoning 10% of the attendance by the Principal for reasons such as medical grounds, participation in University level sports, cultural activities, seminars, workshops, and paper presentation.

9.2 The basis for the calculation of the attendance shall be the term prescribed by the institution by its calendar of events. For the first semester students, the same is reckoned from the date of admission to the course.

9.3 The students shall be informed about their attendance position in the first week of every month by the College so that the students shall be cautioned to make up for the shortage.

9.4 A candidate having a shortage of attendance (<75%) in any course(s) registered shall not be allowed to appear for SEE of such course(s). Such students will be awarded an ‘N’ grade in these courses.

9.5 He/she shall have to repeat those course(s) with an ‘N’ grade and shall re-register for the same course(s) core or elective, as the case may be when the particular course is offered next either in a main (odd/even) or summer semester.

9.6 Attendance in CIE and SEE:

Attendance in all examinations both CIE and SEE of each course registered shall be compulsory and there shall not be any provision for re-examinations. Any student against whom any disciplinary action is pending shall not be permitted to attend any SEE in that semester.

10. WITHDRAWAL FROM THE PROGRAMME

10.1 Temporary Withdrawal

a) A student who has been admitted to a degree program of the college may be permitted once during the course to withdraw temporarily, for one semester, on the grounds of prolonged illness or grave calamity in the family, etc., provided:

i. The student applies to the College within 6 weeks of the commencement of the college stating fully the reasons for withdrawal together with supporting documents and endorsement from his parent/guardian.

ii. The College is satisfied with the genuineness of the case and that even by considering the expected period of withdrawal, the student can complete the program requirements (160 credits) within the time limits specified by the university.

iii. The student does not have any dues or demands at the College / University including tuition and other fees as well as library material.

iv. A student availing of temporary withdrawal shall be required to pay such fees and/or charges as may be fixed by the college until his/her name appears on the student’s roll list. The fees/charges once paid shall not be refunded.

v. A student will be entitled to avail of the temporary withdrawal facility only once during his/her studentship. However, any other concession for the concerned student shall have to be approved by the academic council.

10.2 Permanent Withdrawal

Any student who withdraws the admission before the closing date of admission for the Academic Session is eligible for the refund of the deposits only. Fees once paid will not be refunded on any account.

Once the admission for the year is closed, the following conditions govern withdrawal of admissions.

10.3 A student who wants to leave the College for good will be permitted to do so (and take a Transfer Certificate from the College, if needed), only after clearing all other dues if any.

10.4 Those students who have received any scholarship, stipend, or other forms of assistance from the College shall repay all such amounts.

10.5 The decision of the Principal of the College regarding the withdrawal of a student is final and binding.

11. EVALUATION SYSTEM

11.1 The Academic Performance Evaluation of a student shall be according to a Letter Grading System, based on the Class Performance Distribution.

11.2 The Letter grades O, A+, A, B+, B, C, P and F indicate the level of academic achievement, assessed on a decimal (0-10) scale.

11.3 The Letter grade awarded to a student in a course, for which he has registered shall be based on his performance in quizzes, tutorials, assignments etc., as applicable, in addition to two mid- semester examinations and one semester end examination. The distribution of weightage among these components may be as follows.

Semester End Examination (SEE)		:	50% (50 marks)
Continuous Internal Evaluation (CIE)		:	50% (50 marks)
CIE for Non-PBL Courses			
i)	Quizzes, Tutorials, Assignments, Seminars, etc.	:	10 marks
ii)	Mid-semester Examinations	:	40 marks
CIE for PBL/IPCC Courses			
i)	Project Based Learning (PBL)	:	50 marks
ii)	Mid-semester Examinations	:	40 marks
iii)	Quizzes, Tutorials, Assignments, Seminars, etc.	:	10 marks
60% weightage for theory + 40% weightage for PBL/Practical			

Any variation, other than the above distribution, requires the approval of the pertinent DUGC and Academic Council.

11.4 The letter grade awarded to a student in a 0-0-P (Practical) course, is based on an appropriate continuous evaluation scheme that the course instructor shall evolve, with the approval of the pertinent DUGC and the performance in SEE held on the specified period in a semester.

11.5 Evaluation Scheme *(Refer to Appendix-B for detailed evaluation guidelines)*: The course Instructor shall announce in the class and/or display at the Notice board/faculty door/website the details of the Evaluation Scheme, including the distribution of the weightage for each of the components and method of conversion from the raw scores to the letter-grades within the first week of the semester in which the course is offered so that there are no ambiguities in communicating the same to all the students concerned.

11.5.1 Internship: Mandatory Internship is in two parts. Internship-I (2 weeks) and Internship-II (8 weeks)

11.5.2 **Internship-I**

i. All the students admitted to the 1^{st} semester of engineering programs shall have to undergo Internship-I of 02 weeks (or 80 to 90 hrs duration) during the first year. The internship shall include Inter / Intra Institutional activities. A viva – voce examination (Presentation followed by question-answer session) shall be conducted during the 2^{nd} semester (for lateral entry students, during the 3^{rd} semester) and the prescribed credit shall be included in the 4th-semester grade card.

ii. All the students admitted to the 3rd semester of Engineering programs (Lateral Entry Category) shall have to undergo a mandatory internship of 02 weeks (during the 3^{rd} semester or the intervening period of the 3^{rd} and 4^{th} semesters). The internship shall include Inter/Intra Institutional activities.

iii. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up / complete the internship shall be declared to fail and shall have to complete it during subsequent University examinations after satisfying the internship requirements. (The faculty coordinator or mentor has to monitor the student's internship progress and interact to guide them for the successful completion of the internship).

iv. Procedure for the Evaluation of Internship-I

a) Students should submit the reports immediately on completion of the Internship to the respective mentors.

b) The Examination of the internship will be carried out by the mentor.

c) The Internship-I shall be slated for 100 marks CIE only and will not have SEE.

d) Internship-I marks are based on CIE marks (25 marks for the first presentation, 25 marks for the second presentation, and 50 marks for the report and final presentation).

e) A Viva-Voce examination is conducted during I/II/III Semesters (Presentation followed by question-answer session) and the prescribed credit shall be included in the IV semester grade card.

11.5.3 **Internship-II**

i. All the students admitted to engineering programs shall have to undergo Internship-II of 08 weeks during the second and third year of their

Engineering studies.

ii. During the intervening period of the IV & V semesters and VI & VII semesters, students shall be ready for industrial experience. Therefore, they shall choose to undergo 8 weeks Internship involving Innovation / Entrepreneurship/ or short-term (about 2 weeks) societal-related activities and 6 weeks Industry Internship.

11.5.4 **Project work evaluation:** The evaluation of CIE of the project work shall be based on the progress of the student in the work assigned by the project supervisor, periodically evaluated by him/her together with a department committee constituted for this purpose. Seminar presentation, project report, and final oral examination conducted by the project evaluation committee at the department level shall form the SEE of the project work.

11.5.5 In the case of other requirements, such as seminar, field work, or comprehensive viva voce, if any, the assessment shall be made as laid down by the DUGC/Academic council.

11.5.6 There shall be no re-examination for any course in the credit system. However, students

- who have abstained from attending CIE or SEE without valid reasons ("N" grade), or
- who have failed (F grade) to meet the minimum passing standards prescribed for CIE and/or SEE or
- who have been detained for shortage of attendance or who have withdrawn (W grade) who have dropped any course shall be required to re-register for such course(s) and go through CIE and SEE again and obtain a grade equal to or better than "P" Grade in each case.
- While such students should re-register for the same course(s) if core, they can re-register for the alternative course(s) from among the elective courses, as the case may be. The re-registration shall be possible when the particular course is offered again either in a main (Odd/Even) or summer semester.

11.6 Qualifying standards

Evaluation Method	Qualifying Standard
Sessional (CIE)	Score: ≥40% (≥20 marks)
Terminal (SEE)	Score: ≥40% (≥20 marks)
For securing a final Pass	Total **40 % of the Course maximum marks (100)** i.e., the sum of the CIE and SEE marks prescribed for the Course is desired.

11.7 Grading System

The letter grade awarded to a student for his/her performance in a course is based on Absolute Grading.

11.7.1 Absolute Grading – Letter Grade and its range

The grade point scale for absolute grading

Marks Range (%)	Grade Point	Letter Grade	Descriptor	Classification	CGPA
90 & above	10	O	Outstanding	First Class with Distinction	**7.00-& above**
80-89	9	A+	Excellent		
70-79	8	A	Very Good		
60-69	7	B+	Good	First Class	**6.00-6.99**
55-59	6	B	Above Average	Second Class	**5.50-5.99**
50-54	5	C	Average		**5.00-5.49**
40-49	4	P	Pass	Academic Probation / Non-compliance	**CGPA < 5.00***
00-39	0	F	Fails		
Absent	0	AB	Absent	Fail	

* If a student secures CGPA< 5.0 at any point of time during his/her studies, he/she will be on Academic Probation/Noncompliance (refer section 14.2 and 17.3 for more details.)

i. Grade "N": A candidate having shortage of attendance (<75%) in any course(s) or CIE marks less than 40% shall not be allowed to appear for SEE of such course(s). Such students will be awarded 'N' grade in these courses with a grade point of 0.

ii. The grade points given above help in the evaluation of credit points earned by the student in a course as the credit points are equal to the number of credits assigned to the course multiplied by the grade points awarded to the student in that course. This shall be used in Arriving at the credit index of the student for that semester, as it is the sum total of all the credit points earned by the student for all the courses registered in that semester.

11.7 Earning of Credits

A student shall be considered to have completed a course successfully and earned the credits if he/she secures an acceptable letter grade in the range of O-P. The letter grade "F" in any course implies the failure of the student in that course and no credits earned.

11.7.1 The Transitional Grades "I", "W" and "X" would be awarded by the teachers in the following cases. These would be converted into one or the other of the letter grades (O-F) after the student completes the course requirements.

11.7.2 Grade “I”: To a student having attendance ≥85% and CIE ≥70%, in a course, but remained absent from SEE for valid & convincing reasons acceptable to the College, like:

i. Illness or accident, which disabled him/her from attending SEE.

ii. A calamity in the family at the time of SEE required the student to be away from the College.

iii. However, the committee chaired by the Principal is authorized to relax the requirement of CIE ≥ 70% if the student is hospitalized or advised long-term rest after discharge from the hospital by the Doctor.

iv. Students who remain absent for Semester End Examinations due to valid reasons and those who are absent due to health reasons are required to submit the necessary documents along with their request to the Controller of Examinations to write Makeup Examinations within 2 working days of that examination for which he or she is absent, failing which they will not be given permission.

11.7.3 Grade “W”: To a student having satisfactory attendance at classes, but withdrawing from that course before the prescribed date in a semester under Faculty Advice

11.7.4 Grade “X”: To a student having attendance ≥85% and CIE ≥70%, in a course but SEE performance could result in an F grade in the course. (No “F” grade will be awarded in this case, but the student’s performance record is maintained separately).

11.8 Summer / Fast Track semester

11.8.1 The students who have satisfied CIE and Attendance requirements for the course/s and obtained an F grade in SEE are permitted to appear directly in ensuing examination/s as backlog paper/s. The students need not re-register for such course/s in the summer / fast track semester. In case the student wishes to improve CIE/ he/she has to re-register for the summer / regular semester as and when offered next.

11.8.2 The student who obtains required attendance and CIE in the summer semester, but obtains an 'F' grade in SEE; is permitted to appear for SEE subsequently as backlog course/s. The student need not repeat the course for Attendance and CIE.

11.8.3 The course/s for which the student does not possess satisfactory attendance and CIE score shall be marked as ‘N’ on the Grade sheet. Such students are not permitted to SEE for the Courses marked as ‘N’ on the Grade sheet. The students have to re-register only for course/s marked as ‘N’ in the summer/ subsequent semester whenever that course is offered and obtain the required CIE and attendance. Subsequently, they are eligible to appear for SEE in such course/s.

11.8.4 Courses with Transitional Grades viz "W”, "I", and "X" are also eligible to register in the summer semester in case they wish to improve their score in CIE.

11.8.5 All courses may not be offered in the summer semester. It is the discretion of the University to offer the courses based on the availability of resources. The Institutes shall notify timetable for the summer semester well in advance.

11.8.6 Summer Semester is optional; it is for the student to make the best use of the opportunity.

11.8.7 A student is permitted to register for a maximum of 16 credits in the Summer / fast track semester.

11.8.8 A student has to choose those courses which are offered by the Institution in a given summer Semester.

11.8.9 In the summer semester, each course needs to be offered for the required number of lectures/ tutorial/ laboratory hours as prescribed in the syllabus.

11.9 Grade Card

Each student shall be issued a Grade Card at the end of each semester. This will have a list of all the courses registered by a student in the semester, together with their credits, the letter grades with grade points awarded. Only those courses registered for credit and having grade points shall be included in the computation of the students' performance like SGPA and CGPA and the courses taken for audit will not form part of this computation. The results of mandatory courses, which are of the non-credit type shall also be reflected in the Grade card as PP (for Passed) or NP (for not passed). **Each UG student shall have to obtain the grade PP in each mandatory course to qualify for the Degree awarded by the university.**

11.10 Re-Valuation and paper seeing.

Re-totalling of marks is permitted only for theory papers. The University, on application within the stipulated time and remittance of a prescribed fee for revaluation, shall permit revaluation for the course/s applied. The marks obtained after re-valuation shall be the final marks awarded.

11.11 The Make Up Examination

The Make Up Examination facility would be available to students who may have missed to attend the SEE of one or more course(s) in a semester for valid reasons and given the "I" grade; Also, students having the "X" grade shall be eligible to take advantage of this facility. **The makeup examination would be held as per dates notified in the Academic Calendar during the summer semester.** However, it would be possible to hold a makeup examination at any other time in the semester with the permission of the Academic Council of the College. In all these cases, the standard of makeup examinations shall be same as the regular SEE for the course(s).

a) All the "I" and "X" grades awarded to the students would be converted to appropriate letter grades after the make-up examinations. Any outstanding "I" and "X" grades after the last scheduled make-up examinations shall be automatically converted to "F" grade.

b) All the "W" grades awarded to the students would be eligible for conversion to the appropriate letter grades only after the concerned students re-register for these courses in a main/ Summer semester and fulfill the passing standards for their CIE and (CIE+SEE).

11.12 Rules for grace marks

a. Grace marks up to 1% of the maximum total marks of the courses for which he/she is eligible and have registered (non-credit courses excluded) in the examination or 10 marks whichever is less shall be awarded to the failed course(s), (with a restriction of a maximum of 5 marks per course) provided on the award of such grace marks the candidate passes in that course(s).

12. EVALUATION OF PERFORMANCE

The overall performance of a student will be indicated by two indices:
SGPA; which is the Semester Grade Point Average, and CGPA which is the Cumulative Grade Point Average.

SGPA for a semester is computed as follows.

$$SGPA = \frac{\sum[(Course\ Credits) \times (Grade\ Point)]\ \text{(for all courses in that semester)}}{\sum[Course\ Credits]}$$

CGPA is computed as follows:

$$CGPA = \frac{\sum[(Course\ Credits) \times (Grade\ Point)]\ \text{(for all courses excluding those with F grades until that semester)}}{\sum[Course\ Credits]\ \text{(for all courses excluding those with F grades until that semester)}}$$

13. COMMUNICATION OF GRADES

The SGPA and CGPA respectively, facilitate the declaration of academic performance of a student at the end of a semester and at the end of successive semesters. Both would be normally calculated to the second decimal position.

14. REQUIREMENTS OF VERTICAL PROGRESSION (PROMOTION / ELIGIBILITY TO HIGHER SEMESTERS)

14.1 All students are promoted to their next semester or year of their programme, irrespective of the academic performance.

14.2 However, at any stage of his/her study, if a student reaches a CGPA below 5.00, the student will be on **Academic Probation** and is permitted to register for a maximum of 16 credits during odd semester of an academic year. However, the student has the choice to re-register for the courses/courses in which he/she has obtained an 'F'/ 'N' grade.

14.3 A Student shall be declared fail if he / she

(i) Has not satisfied the CIE requirements of any Course/s.

(ii) Has not appeared for the SEE even after satisfying the attendance and CIE requirements.

14.4 Vertical Progression for regular students who have taken admission to first year:

Normally students are expected to complete a minimum of 85% of credits by the end of 7th semester. However, **for submission for B.Tech. Major Project in 8th semester, student should have completed at least 122 credits.**

14.5 Vertical Progression in case of Diploma students admitted to Second year (lateral entry):

14.5.1 Lateral entry students should complete at least 85% of credits by the end of the 7^{th} semester. However, for **submission of B.Tech. Major Project in 8^{th} semester, the student should have completed at least 88 credits.**

14.5.2 Diploma students should register for mandatory non-credit Mathematics Courses Bridge Courses (i) Calculus and Laplace Transforms and (ii) Probability and Differential Equations prescribed during III and IV semesters respectively. They shall attend these bridge course classes during the respective semesters to satisfy attendance and CIE requirements.

14.5.3 Completion of Mathematics Courses Bridge Courses (i) Calculus and Laplace Transforms and (ii) Probability and Differential Equations shall be mandatory for the award of the degree.

14.6 Termination from the programme

A student shall be required to withdraw (discontinue) from the programme and leave the college on the following grounds.

i) Failure to secure a minimum CGPA of 5.0 at the end of 8 years (6 years for lateral entry students)

ii) Failure to earn 160 credits (120 for lateral entry students) in 8 years (6 years for lateral entry students) of duration from the year of admission including the duration of temporary withdrawal (leave of absence).

iii) Absence from classes for more than six weeks at a time in a semester without leave of absence being granted by competent authorities.

iv) Failure to meet the standards of discipline as prescribed by the college from time to time.

15. AWARD OF CLASS

Sometimes, it would be necessary to provide equivalence of these averages, viz., SGPA and CGPA with the percentages and/or Class awarded as in the conventional system of declaring the results of university examinations. This can be done by prescribing certain specific thresholds in these averages for Distinction, First Class and Second Class. This can be seen from the following Table.

Percentage Equivalence of Grade Points (For a 10-Point Scale)

Grade Point	Percentage of Marks*	Class
≥ 7.00	$\geq 70\%$	Distinction
≥ 6.00	$\geq 60\%$	First Class
$5.0 \geq$ CGPA <6.00	$50\geq$ Percentage $< 60\%$	Second Class

Percentage * = (CGPA) x 10

16. APPEAL FOR REVIEW OF GRADES

a. The entire process of evaluation shall be made transparent, and the course instructor shall explain to a student why he/she gets whatever grade he/she is awarded, if and when required. A mechanism for review of grade is incorporated in the evaluation system. However, before appealing for such review, a student shall first approach the concerned course Instructor and then the concerned DUGC, with the request to do the needful; and only in situations where satisfactory remedial measures have not been taken, the student may then appeal to the Department Academic Appeals Boards (DAAB) before the date specified in Academic Calendar, by paying the prescribed fees.

b. The fee for such an appeal will be decided by the Senate from time to time. If the appeal is upheld by DAAB, then the fee amount will be refunded to the student.

17. AWARD OF DEGREE

17.1 (1) B.Tech. Degree

a) Students shall be declared to have completed the Programme of B.Tech. degree and is eligible for the award of degree, provided the students have undergone the stipulated Course work of all the semesters under the Scheme of Teaching and Examinations and has earned the prescribed number of credits (160 credits for regular students registered for 4-year degree programmes & 120 for lateral entry students).

b) For the award of degree, a CGPA≥5.00 at the end of Programme shall be mandatory.

c) Completion of Additional Mathematics I and II, shall be mandatory for the award of degree to lateral entry diploma students.

d) Earning of Activity Points:

i. Every student entering 4-year degree programme should earn 100 activity points & every student entering 4-year degree programme through Lateral Entry should earn 75 activity points as per the AICTE Activity Point Programme for the award of Engineering degree

ii. The activities can be spread over the years (duration of the programme) any time during the semester weekends and holidays, as per the interest & convenience of the students from the year of entry to the programme.

iii. The Activity Points earned shall be reflected on the student's eight semester Grade Card.

iv. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

v. In case students fail to earn the prescribed activity Points before the commencement of 8th semester examinations, eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

17.2 Honours/ Minors Degree

17.2.1 B.Tech. (Honours) Degree

i. Students must earn a minimum of 18 additional credits in his/her major program discipline entitles a student to get an 'Honours' credential.

ii. Students have to pay additional fees for all the courses registered for 'Honours'.

iii. Students with a minimum of 7.5 CGPA and no backlog at the end of the 4th semester will qualify for registering for courses under the 'Honours credential.

iv. Students shall register for 'Honours' courses from the 5th semester onwards.

v. Students should register for additional courses and plan to take courses that are prescribed under that 'Honours' list as per 'pre-requisite' courses to earn the 'Honours' credential.

vi. Students who wish to acquire an 'Honours' credential need to carry out 'Honours' course registration along with their regular semester course registration.

vii. He/she accumulates credits by registering for the required courses, and if the requirements for 'Honours' are met within the prescribed minimum time limit of the program, the 'Honours' will be awarded along with the degree.

viii. Also, the student should meet the following requirements to become eligible for the 'Honours award.
- Minimum CGPA of 7.5 in this major discipline at the end of the 8th semester
- Minimum CGPA of 7.0 in the registered 'Honours' courses

ix. In case a student withdraws from the 'Honours' registration in the middle of the program, the 'Honours' courses completed will be converted to 'Audit' courses and indicated accordingly in subsequent Grade Sheets and Consolidated Grade Sheets.

x. It must be noted that the 'Honours' award will be mentioned in the Degree Certificate as "Bachelor of Technology in (specialization) with Honours".

xi. This fact will also be reflected in the Consolidated Grade Sheet under a separate heading 'Honours' with similar details shown for other credited courses and the CGPA for 'Honours' will be indicated at the end of the list of courses under 'Honours'.

xii. The grades obtained in the courses credited towards the 'Honours' award are not counted and shall not influence the GPA/ CGPA of the 'program' student has registered.

17.2.2 Minor Degree

i. Students have to earn a min of 18 additional credits from the courses focused on discipline other than his/her major program discipline entitles a student to get a 'Minor' credential.

ii. Students have to pay additional fees for all the courses registered for 'Minor'.

iii. Students with a minimum of 5.0 CGPA and no backlog at the end of the 3rd semester will only qualify for registering for the course under the 'Minor' credential.

iv. Students shall register for 'Minor' degree courses from the 4th semester onwards.

v. All Departments will offer 'Minors' in their varied disciplines and will prescribe what set of courses and/or projects is necessary for earning a minor in that discipline.

vi. Students should register for additional courses and plan to take courses that are prescribed under that 'Minors' list as per 'pre-requisite' courses to earn the 'Minor' credential.

vii. If any of the courses listed under the 'minor' option is a course listed under his/her curriculum as PCC then the student cannot opt for that 'Minor', since all minor courses need to be earned as additional courses to his/her program curriculum and depts decision is final and binding.

viii. Students who wish to acquire a 'Minor' can register for 'Minor' courses along with their regular semester course registration.

ix. Also, the student should have a minimum CGPA of 5.0 in the 'Minor' courses registered to become eligible for the Minor credential. This fact will also be reflected in the Consolidated Grade Sheet under a separate heading 'Minor in (specialization)'.

x. If the course requirements for a particular 'Minor' are met within the prescribed minimum time limit of the program, the minor will be awarded along with the degree, and it will be mentioned in the Degree Certificate as "Bachelor of Technology in (Major discipline) with Minor in (specialization)."

xi. In case a student withdraws from the 'Minor', the 'Minor' courses completed, will be converted to 'Audit' courses and indicated accordingly in subsequent Grade Sheets and Consolidated Grade Sheets.

xii. The grades obtained in the courses credited towards the 'Minor' award are not counted and shall not influence the GPA/ CGPA of the program the student has registered for.

17.2.3 Additional norms for Honours/Minors

i. Students shall register for additional courses to earn Honours/Minors in consultation with their Class Advisor from the list of courses suggested by the DUGC.

ii. DUGC may recommend Massive Open Online Courses (MOOCs)/SWAYAM/NPTEL courses to students who wish to register for Honours/Minors after justifying and establishing the equivalence of the curriculum. The decision of DUGC should be communicated to the Dean of Academics and Controller of Examinations for seeking approval.

iii. A maximum of 40% credits prescribed for Honors/Minors may be earned through MOOCs/SWAYAM/NPTEL

iv. Students may choose to take up additional course work, from the MOOCs courses list suggested by various departments (which can be from SWAYAM/NPTEL) with proctored examinations as approved by the University and complete the same before the last working day of the VIII semester with a final score (online assignments: 25 % + Proctored examination: 75 %) leading to the following certificates: Completed the course (40-59)– ELITE (60 to 75 %) or ELITE + SILVER (76 to 89 %) or ELITE + GOLD (≥ 90 %)

v. In case, in MOOCs (ex: Coursera), there is no proctored examination, the University will conduct a SEE as deemed to be fit for the award of Credits.

vi. The Credit equivalence for online courses shall be as follows –
- 4 weeks of online course duration – 1 credit (approx. 13-14 hours)
- 8 weeks of online course duration – 2 credits (approx. 26-28 hours) and
- 12 weeks of online course duration – 3 credits (approx. 39-42 Hours)

17.3 Noncompliance

17.3.1 Noncompliance of CGPA ≥ 5.00 at the end of the Program

a) Students, who have completed all the courses of the Program but do not have a CGPA ≥ 5.00 at the end of the Program, shall not be eligible for the award of the degree.

b) In the cases of 17.3 (1), a student shall be permitted to appear again for SEE in course/s (other than Internship, Technical seminar, Project (Mini and Major), and Laboratories) of any Semester/s without the rejection of CIE marks for any number of times, subject to the provision of a maximum duration of the Program to make up the CGPA equal to or greater than 5.00 for the award of the Degree.

c) Students shall obtain written permission from the Controller of Examinations to reappear in SEE to make up the CGPA equal to or greater than 5.00.

d) In case, the students earn improved grade/s in all the reappeared course/s, the CGPA shall be calculated considering the improved grade/s. If it is ≥5.00, the students shall become eligible for the award of the degree. If CGPA <5.00, the students shall follow the procedure laid in 17.3.1 (b).

e) In case, the students earn improved grade/s in some course/s and the same or lesser than the previously earned pass grade/s in the other reappeared course/s, the CGPA shall be calculated considering the improved grade/s and the pass grades earned before the reappearance. If it is ≥5.00, the students shall become eligible for the award of the degree. If CGPA<5.00, the students shall follow the procedure laid in 17.3.1 (b).

f) In case, the students earn improved grade/s in some courses and fail in the other reappeared course/s, the CGPA shall be calculated by considering the improved grade/s and the previously earned pass grade/s of the reappeared course/s in which the students have failed. If it is≥5.00, the students shall become eligible for the award of the degree. If CGPA <5.00, the students shall follow the procedure laid in 17.3.1 (b).

g) In case, the students fail (i.e., earns an F grade) in all the reappeared course/s, pass grade/s of the course/s earned by the students before reappearance shall be retained. In such cases, the students shall follow the procedure laid in 17.3.1 (b).

17.3.2 Noncompliance with Project/ Mini project

The project/mini project shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the mini-project shall be declared to fail in that course and shall have to complete the same during subsequent University examinations after satisfying the Mini-project requirements.

17.3.3 Noncompliance of Internship

All the students of B. Tech shall have to undergo mandatory Internship-I and Internship-II for a total of 10 weeks to earn a total of 10 credits in parts during the vacations at the end of the 1/2/3 academic year. The evaluation of Internship shall be during IV and VIII semesters. The internship shall be considered mandatory for the award of a degree. Those who do not take up/complete the internship shall be declared to fail in that Course and shall have to complete the same during subsequent University examinations after satisfying the internship requirements.

The maximum duration for a student for complying with the Degree requirements is 16 – semesters from the date of first registration for his/ her first semester (8 years from the date of admission to the first year, (12 semesters / 6 years from the date of admission for lateral entry student)).

18. GRADUATION REQUIREMENTS AND CONVOCATION

18.1 A student shall be declared to be eligible for the award of the degree if he/she has

a) Fulfilled "Award of Degree" Requirements

b) No Dues to the College, Departments, Hostels, Library, Central Computer Centre and any other centers

c) No disciplinary action pending against him/her.

18.2 The award of the degree must be recommended by the Governing council.

18.3 Convocation: Degree will be awarded for the students who have graduated during the preceding academic year. Students are required to apply for the Convocation along with the prescribed fees, after having satisfactorily completed all the degree requirements (refer "Award of Degree") within the specified date in order to arrange for the award of the degree during convocation.

19. AWARD OF PRIZES, MEDALS, & RANKS

19.1 For the award of Prizes and Medals, the conditions stipulated by the Donor may be considered as per the statutes framed by the University for such awards. Sometimes, it would be necessary to provide equivalence of these averages, viz., SGPA and CGPA with the percentages and/or Class awarded as in the conventional system of declaring the results of University examinations. This can be done by prescribing certain specific thresholds in these averages for Distinction, First Class and Second Class as described in Section 15.

19.2 An attempt means the appearance/registration of a candidate for an examination in one or more courses either in part or failing a particular examination.

i) A candidate who fails/remaining absent (after submitting exam application) in the main examination and passes one or more subjects/courses or all subjects/courses in the supplementary/Make-up examination such candidates shall be considered as taken more than an attempt.

19.3 Merit Certificates and University Medals/ will be awarded on the basis of overall CGPA, governed by the specific selection criteria that may be formulated by the University for such Medals / Awards

i) Only those candidates who have completed the Program and fulfilled all the requirements in the minimum number of years prescribed (i.e., 3 years for Diploma lateral entry students or 4 years for students joined after 12th standard) and who have passed each semester in the first attempt are eligible for the award of Merit Certificates and /or University Medals.

ii) Candidates who pass the subjects in the supplementary/make-up examinations are not eligible for the award of Medal or Merit Certificate.

20. CONDUCT AND DISCIPLINE

20.1 Students shall conduct themselves within and outside the premises of the College in a manner befitting the students of an Institution of National Importance.

20.2 As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

20.3 The following acts of omission/ or commission shall constitute gross violation of the Code of Conduct and are liable to invoke disciplinary measures:

i. Ragging.
ii. Lack of courtesy and decorum; indecent behavior anywhere within or outs ide the campus.
iii. Willful damage or stealthy removal of any property/belongings of the College/Hostel or of fellow students/citizens.
iv. Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs.
v. Mutilation or unauthorized possession of Library books.
vi. Noisy and unseemly behavior, disturbing studies of fellow students.
vii. Hacking in computer systems (such as entering into other Person's area without prior permission, manipulation and/or Damage of computer hardware and software or any other Cybercrime etc.).
viii. Plagiarism of any nature.
ix. Any other act of gross indiscipline as decided by the Senate from time to time.
x. Use of Mobile in the college Academic area.
xi. Smoking in College Campus and supari chewing.
xii. Unauthorized fund raising and promoting sales.
xiii. Commensurate with the gravity of offence the punishment may be:

reprimand, expulsion from the hostel, debarring from an examination, disallowing the use of certain facilities of the College, rustication for a specified period or even outright expulsion from the College, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

20.4 For an offence committed in (i) a hostel (ii) a department or in a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department, and the Dean (Academics), respectively, shall have the authority to reprimand or impose fine.

20.5 All cases involving punishment other than reprimand shall be reported to the principal.

20.6 Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Controller of Examinations for taking appropriate action.

20.7 Note: Students are required to be inside the examination hall 20 minutes before the commencement of examination. This is applicable for all examinations (Semester end/Supplementary/makeup) henceforth. Students will not be allowed inside the examination hall after the commencement, under any circumstances.

****

APPENDIX - A

Definitions, terminology, and abbreviations

1. **Nitte DU / University**
   a. Refers to Nitte (Deemed to be University)

2. **BoM**
   a. Refers to Board of Management of Nitte (Deemed to be University)

3. **BoS**
   a. Refers to Board of Studies in Electrical and Electronics Engineering

4. **Institute/Institution**
   a. Refers to NMAM Institute of Technology, Nitte

5. **Program**
   a. A range of learning experiences over a specified period, leading to the award of a degrees / diploma / certificate. A program is completed when the courses that make up the program are completed, and other requirements as specified in the program regulations are met.

6. **Course**
   a. A unit of learning that typically lasts one semester, led by one or more teachers, for a fixed roster of students. Often referred to as a “subject”. A course has identified course outcomes, modules / units of study, specified teaching-learning methods and assessment schemes. A course maybe designed to include lectures, tutorials, practical, laboratory work field work, project work, internship experiences, seminars, self-study components, online learning modules etc. in any combination.

7. **Semester**
   a. An academic session, usually of 16 weeks duration, with a minimum of 90 working days during which coursework and assessments are to be completed. Typically, two semesters make up an academic year, with the first of these referred to as Odd Semester and the second as Even Semester.
   b. An additional short semester (usually 8 weeks) maybe offered between an even semester and subsequent odd semester (in the interval between two academic years) and are termed as summer semester. Summer semester is offered to enable students to register for:
      i. Fast-tracked courses required for clearing backlog courses
      ii. Fact-tracked courses for earning additional credit / completing non-credit mandatory requirement
      iii. Value added courses
      iv. The courses offered in summer semesters are bound by the same regulations as that of regular semesters, except that they are run at an accelerated pace to provide the required contact hours and conduct assessments within the 8-

week.

8. Credit

a. A unit by which the course work is measured. It determines the number of hours of formal learning (contact hours) required per week. Credits are calculated based on the concept of "notional learning time". Notional learning time is the number of hours which a learner is expected to spend, on average, to achieve the specified learning outcomes of the course. This may comprise a variable combination of scheduled learning activities, (lectures, seminars, labs etc.) and self-directed learning time (reading required prior to classes, working on assignments, examination preparation and completion of assessments).

9. Credit equivalence of notional learning time for different types of activities

a. The credit values assigned to various teaching-learning activities are as follows:

Type of teaching-learning	**Nature of activity**	**No. of contact hours per week equivalent to one credit**	**Total number of contact hours over a 16-week semester that is equivalent to one credit**
Lectures / Seminars / synchronous virtual classes / synchronous webinars	Scheduled instruction	1:1	16
Tutorials	Scheduled instruction	2:1	32
Supervised Demonstrations / Laboratory sessions / Studio / Workshops / Workplace simulation /Skill Practice Sessions	Scheduled instruction	2:1	32
Supervised Field visits / community visits/Internships	Scheduled instruction	3:1	48
Scheduled self-directed study (individual or group)	Scheduled instruction	2:1	32
Asynchronous E-Learning modules (structured self-directed study	Independent learning	2:1	32
Student Seminar	Independent / small group learning	2:1	32
Project work / dissertation	Independent / small group learning	3:1	48

Internship for credit	Industry placement/ Research Internship	3:1	48

10. Choice-based credit system (CBCS)

A program structure for higher education which requires students to earn a minimum of credits by completing various types of courses, including electives, which facilitate a student to have some freedom in selecting his/her own choices, within as well as across disciplines.

11. Course registration

Refers to formal registration of the Courses in the study in every semester (Credits and Audit) by every student under the supervision of a faculty advisor. The institution will maintain records of the same and communicate it to the University.

12. Learning outcomes

a. Program Outcomes (PO) - Statements defining the skills, knowledge and attitude that graduates of a program will be able to demonstrate upon completing the program.
b. Course Outcomes (CO) - Statements defining the skills, knowledge and attitude that students will be able to demonstrate upon completing the course. COs are mapped to the POs such that attaining the course outcomes leads to attainment of program outcomes.
c. Attainment of POs-COs are mapped to the POs such that attaining the course outcomes leads to attainment of program outcomes.

13. Evaluation

For all courses, evaluation will be based on both formative assessment (Continuous Internal Evaluation, CIE) and summative assessment (Semester End Evaluation, SEE). Weightage for CIE and SEE will be 50% each.

13.1 Continuous Internal Evaluation (CIE)

Refers to periodic and continuous *formative assessment* of student’s performance during the semester by the teacher(s) of the course with the aim of providing timely feedback to students and for guiding “course corrections” by the teachers. The assessment methods may include tests, quizzes, assignments, project evaluations, portfolio evaluations, seminar assessments etc. CIE will have a weightage of 50% in the determination of final grading of the course.

13.2 Semester End Evaluation (SEE)

Refers to *summative assessment* that covers the entire course syllabus, conducted by the University, at the end of semester. Appropriate assessment methods aligned with the learning domain and teaching-learning methods are to be used. CIE will have a weightage of 50% in the determination of final grading of the course.

14. Grading

Course Grade refers to a qualitative measure of performance of a student in each course, based on the percentage of marks secured in Continuous Internal Evaluation (CIE) and Semester End Evaluation (SEE). A Letter grade is awarded for each course.

15. Semester Grade Point Average (SGPA)

Refers to the measure of a student's academic performance in a semester. It is calculated based on the credits and the grades obtained in the courses offered in the semester.

16. Cumulative Grade Point Average (CGPA)

Refers to the measure of the cumulative performance of a student in all the previous semesters and is computed from the 2nd semester onwards. It is calculated based on the credits and the grades obtained in all the courses taken.

17. Academic Bank of Credits (ABC)

The Academic Bank of Credits is a national-level facility for "credit transfer". It is provided by the Ministry of Education, Govt. of India, to promote the flexibility of the curriculum framework and interdisciplinary/multidisciplinary academic mobility of students across the Higher Education Institutions in the country. The banking and redemption of credits through ABC will be governed by the University's guidelines.

Appendix-B

Evaluation Guidelines

CIE and SEE details for various types of courses

1. Theory: PCC/IPCC/PEC/OEC

1.1. Scheme of examinations: CIE+SEE =50+50=100 marks

1.2. Continuous internal evaluation (CIE):

1.2.1. CIE (Non-PBL Courses)

Type of Questions	Questions to be set (Can have sub questions a and b)	Questions to Be answered	Marks per question	Total marks
Mid Sem Exam-1				
40% of the total syllabus (Unit-1) (15 Teaching hours)				
Descriptive Part-1	2	1	10	10
Descriptive Part-2	2	1	10	10
Mid Sem Exam-2				
40% of the total syllabus (Unit-2) (15 Teaching hours)				
Descriptive Part-1	2	1	10	10
Descriptive Part-1	2	1	10	10
TASKS				
TASK	Task comprises of 5 class tests/quizzes/assignments conducted for each unit for a max mark of 10. All tests/quizzes/Assignments are compulsory			10
Maximum Marks				**50**

1.2.2 CIE (for courses having Project Based Learning (PBL) component)

Type of Questions	Questions to be set (Can have sub questions a and b)	Questions to be answered	Marks per question	Total marks
Mid Sem Exam-1				
40% of the total syllabus (Unit-1) (15 Teaching hours)				
Descriptive Part-1	2	1	8	8
Descriptive Part-2	2	1	7	7
Mid Sem Exam-2				
40% of the total syllabus (Unit-2) (15 Teaching hours)				
Descriptive Part-1	2	1	8	8

Descriptive Part-1	2	1	7	7
Project Based Learning (PBL)				
PBL	PBL comprises of implementation of theoretical concepts through projects / problem solving			20
Maximum Marks				**50**

1.2.3 Semester End Evaluation (SEE): 3 Hours Duration

Type of Questions	Module & Teaching hours	Questions to be set (Can have sub questions a, b and c)	Questions to be answered	Marks per question	Total marks
MCQ	Entire Syllabus	10 or 20	All Questions	2 or 1	20
Descriptive	• Unit-1 • 15 teaching hours	3	2	16	32
Descriptive	• Unit-2 • 15 teaching hours	3	2	16	32
Descriptive	• Unit-3 • 10 teaching hours	2	1	16	16
				Maximum Marks	**100**
SEE Marks with 50% Weightage					**50**

1.2.4 CIE & SEE for various types of courses

Sl. No.	Courses		Evaluation scheme			
			CIE (Minimum eligibility marks 40% of Max marks to appear for SEE)		SEE (Minimum Passing marks 40 % of Max marks)	
			Max Marks	Min eligibility marks required	Max Marks	Minimum passing marks
1	Integrated Professional Core Course (IPCC)	Theory	30	12	50	20
		Practical	20	08	---	---
		Total	50	20	50	20
2	PCC with PBL component	Theory	30	12	50	20
		PBL component	20	08	--	--
		Total	50	20	50	20
3	PCC/PEC/OEC		50	20	50	20
4	Laboratory		50	20	50	20
5	Drafting		50	20	50	20
6	Mini Project		100	40	---	---
7	Inter/Intra Institutional Internship (2 weeks)		100	40	---	---

8	Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship (In single or two stretches =Total 8 weeks)	100	40	100	40
9	Research Internship/ Advanced Industry Internship/Project work	100	40	100	40
10	Seminar	100	40	---	---

All university examination (SEE) shall be conducted for maximum of 100 marks. For assigning the letter grade the university examination marks secured by a student, except in case of serial no. 06, 07 and 10 shall be reduced to 50 marks and added to CIE marks. If the total marks result a fraction during reduction, it shall be rounded off to a nearest higher value.

2 Laboratory/Practical Course

2.1 Split-up of Marks for evaluation of Practical for 50 CIE marks and 50 SEE marks.

2.2 Split-up of Marks for evaluation of Laboratory work:

2.2.1 Laboratory in-charge faculty will follow rubrics given in Tables below for evaluation of laboratory courses

2.2.2 In the case of Practical, the IA marks shall be based on the laboratory observation, records, viva and at least one practical test.

2.2.3 Continuous Evaluation in every lab session will be done using the format mentioned in the Table to evaluate PO9 (Individual and teamwork) and PO10 (Communication).

2.2.4 Rubrics used for continuous Evaluation of **laboratory courses involving experiments with hardware**

<table>
<tr><th colspan="3">Lab conduction and Record</th><th colspan="3">Lab Internal Assessment</th></tr>
<tr><td colspan="3">Split-up: 60% (30 Marks) of Maximum CIE marks (50).

Each experiment is to be evaluated for conduction with an observation book and record write-up (30 marks per experiment). The final marks for conduction and record is the average of all the specified experiments in the syllabus.</td><td colspan="3">Split-up: 40% (20 Marks) of Maximum CIE marks (50). One test of 20 Marks
In test, conduction of experiment and acceptable result with viva-voce will carry a weightage of 60% per experiment, with the rest 40% for procedural knowledge and regularity of the student.</td></tr>
<tr><th>Rubrics per experiment</th><th>Marks Distribution</th><th>Remarks</th><th>Rubrics</th><th>Marks distribution</th><th>Remarks</th></tr>
<tr><td>Circuit</td><td>02</td><td rowspan="6">Evaluation of Record write- up to include</td><td>Write-up</td><td>04</td><td rowspan="6"></td></tr>
<tr><td>Design</td><td>02</td><td>Conduction</td><td>10</td></tr>
<tr><td>Procedure</td><td>02</td><td rowspan="4">Results</td><td rowspan="4">06</td></tr>
<tr><td>Conduction</td><td>06</td></tr>
<tr><td>Viva</td><td>06</td></tr>
<tr><td>Record write-up</td><td>12</td></tr>
</table>

Total Marks	30	weightage for submissio	**Total Marks**	20	

2.2.5 Split-up of Marks used for continuous Evaluation of laboratory involving experiments with software

Rubrics for Split up of Marks	Methodology / Process Steps per Experiment	Marks
#R1	Observation, Write up of Procedure / Algorithm/ Program execution and Conduction of experiment	12
#R2	Viva – Voce	06
#R3	Record writing	12
	Total Marks for each experiment	30
#R4	Internal Test: Lab Internal Assessment (i) Write-up of Procedure/Program/Algorithm (ii) Conduction/Execution (iii) Viva-Voce	 04 10 06
	Total Marks	20

3. Internship and Evaluation

3.1 Introduction

The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. Developing an internship policy is an impactful strategy for creating a future talent pool for the industry. The internship (a form of experiential learning) program not only helps fresh pass–outs in gaining professional know–how but also benefits corporate sectors. The internship also enhances the employability skills of the student passing out from Technical Institutions.

The following list provides a brief illustrative overview of the knowledge, skills, work habits, and character traits commonly associated with 21st-century skills and to be acquired by graduates:

- Critical thinking, problem-solving, reasoning, analysis, interpretation, and synthesizing information.
- Scientific literacy and reasoning, the scientific method.

- Research skills and practices, interrogative questioning.
- Creativity, artistry, curiosity, imagination, innovation, and personal expression.
- Information and communication technology (ICT) literacy, media and internet literacy, data interpretation and analysis, computer programing.

- Oral and written communication, public speaking and presenting, listening.
- Economic and financial literacy, entrepreneurial skills.
- Global awareness, multicultural literacy, humanitarianism.
- Environmental and conservation literacy, ecosystems understanding.
- Civic, ethical, and social-justice literacy.
- Leadership, teamwork, collaboration, cooperation, and facility in using virtual workspaces.
- Perseverance, self-direction, planning, self-discipline, adaptability, initiative.
- Health and wellness literacy, including nutrition, diet, exercise, and public health and safety.

The internship experience will augment outcome- based learning process and inculcate various attributes mentioned above in a student in line with the graduate attributes defined by the NBA as well as NEP 2020

Following are the intended objectives of internship training.

(i) Expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence create competent professionals in the industry.

(ii) Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

(iii) Expose to the current technological developments relevant to the subject area of training.

(iv) Use the experience gained from the industrial internship in discussions held in the classrooms.

(v) Create conditions conducive to quest for knowledge and its applicability on the job.

(vi) Learn to apply technical knowledge in real industrial situations.

(vii) Gain experience in writing reports in technical works/projects.

(viii) Expose students to the engineer’s responsibilities and ethics.

(ix) Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control and safety measures.

(x) Promote academic, career and/or personal development.

(xi) Expose the students to future employers.

(xii) Make students available to industry for employment.

(xiii) Understand the psychology of the workers and their habits, attitudes, and approach to problem-solving.

(xiv) Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations.

3.2 Academic credit framework for the internship and project work undergone as part of the B.Tech. programme.

- A minimum of 20 credits of Internship/ Entrepreneurial activities / Project work/ Seminar and Inter/ Intra Institutional Training may be counted towards B. Tech. degree programme
- Here, 1 credit is equivalent to minimum 40-45 hours of work. Therefore, a full-time intern is expected to spend 40 - 45 hours per week on Internship, Training, Project work, Seminar activities etc. This will result in about 800 to 900 hours of total internship and project duration for B. Tech programme.
- To derive the benefits of an internship, it is introduced in two/ three stages of the B.Tech. program.
- Internships may be full-time or part-time; they are full-time in the summer vacation and part-time during the academic session. The curriculum is flexible to adjust internship duration. Therefore, opportunities must be provided for experiences that cannot be anticipated when planning the course.
- The departments have the flexibility to schedule internship, Project work, Seminar etc. according to the availability of the opportunities. However, suggested minimum requirement regarding Internship duration and credits are as given in Table -B1.

Table-B1 Suggested Credit Framework for Internship, Project work

Sl. No.	Title	Schedule	Duration	Activities	Credits
1	Internship-I	Ongoing First-year academic session/ Summer vacation after 2nd Semester/ vacation during 3rd semester (for lateral entry students)	02 weeks	Inter/ Intra Institutional Activities (Evaluation in 4th semester)	02
2	Internship-II	a) Summer vacation after 4th Semester	02-04 weeks	Industrial/Govt./ NGO/ MSME/ Rural Internship/ Innovation / Entrepreneurship/ social internship	---
		b) Summer vacation after 6th Semester	04-06 weeks	Industrial/Govt./ NGO/ MSME/ Rural Internship/ Innovation / Entrepreneurship	
		c) Total of a) and b) at the beginning of the 8th semester	08 weeks	Evaluation in 8th Semester	08
3	Project work	6th Semester	6 hours/week	Mini -Project	02
		8th Semester	16 weeks	Extended Industry Internship /Research Internship/ Project work	10
				Report preparation and writing	
				Seminar	01
Total Credits					**23**

Table-1 states that during the ongoing/ summer vacations after the 2nd Semester, students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

During the summer vacation after 4th/ 6th semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry

3.3 Internship Supervision

- **i)** Internship shall be carried out under the supervision of a faculty mentor. The faculty mentor/guide should,
- **ii)** Serve as a teacher, mentor, trainer, critic, leader and boss.
- **iii)** Provide sufficient time to guide the interns. (Interns are students or a trainee who does a job to gain work experience)
- **iv)** Play a vital role, along with the Training and Placement Officer, in providing internship opportunities for the students.
- **v)** Exhibit qualities such as leadership, strong communication skills, and patience.
- **vi)** Provide letter of recommendation in due consultation with students and the industrial organization (if possible) where internship is intended to be carried out, endorsed by the authority (Principal/Institution Internship Coordinator).

3.3.1 Each faculty mentor shall supervise the students/Student batches allotted to them. Often, the supervision may be by an external expert. In such cases, the faculty mentor shall jointly guide the student/s without causing miscommunications/embarrassment to either side.

3.3.2 Depending on the activity taken up by the students, the internship shall be carried out individually or in batches having not more than three students.

3.3.3 Faculty Mentor, along with the external expert, shall scrupulously evaluate the work of an individual student or students of a batch and maintain the relevant documents.

3.3.4 For allotment of CIE marks, the institutions shall prepare the rubrics for each activity offered by the institution as given in Table - B2. The marks shall be allotted by the Internship committee designated by HOD in consultation with the mentors.

3.3.5 For all activities conducted by the institution, the attendance of the students shall be maintained by the faculty and maintained in their respective department.

3.4 Internship-I (Activity based Internship)

While intra activities are within the institution, inter activates shall be between the concerned institution and neighboring institutions. Intra and Inter activities are the activities that are impetus to learning techniques. It adds to comprehensive growth of mind and associated activities.

As the students are at the verge of learning technical aspects and have limited time period of internship, it is preferable to expose students to polygonal activities instead of one type of activity. Therefore, activities completed by the students shall not be one type of activity but can be few within the time period of the internship. In this regard, Intra and Inter Institutional activities shall be completed under the supervision of a faculty on self-learning basis.

The faculty have to kindle the latent abilities of the students, encourage, guide, supervise and shape them to achieve the desired result. Therefore, a learning agenda in the form of specific learning objectives and outcomes shall be prepared prior to the start of the internship.

Whatever the activity/activities that is/are done under Intra and Inter Institutional activities, should ignite the inquisitiveness to learn, enhance the knowledge, thinking ability and imagination, planning, application of mind, execution ability, innovation attitude, listening and understanding, vocabulary, personal expression, public speaking, written communication, oral presentation of the subject matter, acquire leadership qualities and teamwork requirements, responsiveness, ethics, etc.

3.4.1 List of proposed activities

a. Activities concerned with the works of Indian scholars like Charaka and Susruta, Aryabhata, Bhaskaracharya, Chanakya, Madhava, Patanjali, Panini and Thiruvalluvar, among numerous others
b. Activities such as training with higher Institutions or Soft skill training
c. Contribution at incubation/ innovation /entrepreneurship cell of the institute.
d. Learning at Departmental Lab/Tinkering Lab/ Institutional workshop.
e. Working for consultancy/ research project with-in the institute.
f. Learning MS Word, Excel, Microsoft equations, MS drawing tools, MS Power point, etc.
g. Coding.
h. Mini projects using commercially available assembled electronic products.
i. Debates, quizzes, and group discussions: On technical topics already studied (both in Kannada and English).
j. Essay competitions: Both in Kannada and English on technical topics already studied.
k. Survey and study of published literature on the assigned topic: Technical paper survey, Preparation of synopsis. Exposure to technical paper publications.
l. Photography.
m. Short film production: Contemporary aspects, technical aspects etc.
n. Internship in Disaster Management.
o. Solar energy connected activities that help common man.
p. Working with Smart City Administration.
q. Hackathon (it is a design sprint-like event in which computer programmers and others involved in software development, including graphic designers, interface designers, project managers, and others, often including domain experts collaborate intensively on software projects).
r. Industrial Safety, Fire Safety, Electrical Safety, Chemical Process Safety, Food Safety etc.
s. Internship and project work in Indian Knowledge System related Areas/Topics.
t. Industrial visits to Small Scale Industries/ Factories/ Cottage Industries/substation visit etc., and submission of report.

3.5 Documents to be submitted by Students for Internship Evaluation

3.5.1 Student's Diary

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students shall record in the daily training diary the day-to-day account of the observations, impressions, information gathered, and suggestions given, if any, and activities carried out. It should contain the sketches and drawings related to the observations made by the students. The daily training diary should be signed after every day or at least twice a week by the faculty/ in charge of the section (external expert) where the student has been working.

Student's Diary should be submitted by the students along with attendance record. It shall be evaluated on the basis of the following criteria:

- i) Regularity in the maintenance of the diary.
- ii) Adequacy and quality of information recorded.
- iii) Drawings, sketches and data recorded.
- iv) Thought process and recording techniques used.
- v) Organization of the information

3.5.2 Internship report

After completion of Internship, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he / she has observed and learnt in the training period along with the internship outcomes. The training report should be signed by the mentor. The Internship report shall be evaluated on the basis of following criteria and/or other relevant criteria pertaining to the activity completed.

- **i)** Originality.
- **ii)** Adequacy and purposeful write-up.
- **iii)** Organization, format, drawings, sketches, style, language etc.
- **iv)** Practical applications, relationships with basic theory and concepts taught in the appropriate course.
- **v)** Variety and relevance of learning experience.

Procedure for the Evaluation of Internship-I

- **a)** Students should submit the reports immediately on completion of the Internship to the respective mentors
- **b)** The Examination of internship will be carried out by the mentor
- **c)** The Internship-I shall be slated for 100 marks CIE only and will not have SEE.
- **d)** Internship-I marks are based on CIE marks (25 marks for first presentation, 25 marks for second presentation,50 marks for report and final presentation).
- **e)** A Viva-Voce examination conducted during I/II/III Semesters (Presentation followed by question-answer session) and the prescribed credit shall be included in the IV semester grade card

3.5.3 Assessment Rubrics for evaluation of Internship-I (Intra and Inter Institutional Activities)

<table>
<tr><th colspan="6">Table – B2 Internship-I Assessment Rubrics
Scheduled during the first year (Prescribed Period 02 weeks and Prescribed credits: 02)</th></tr>
<tr><th>Sl No</th><th>Sub Activity Head</th><th>Performance/ Appraisal</th><th>Assessment Rubrics (Allotted marks decide the letter</th><th>Proposed Document as Evidence</th><th>Evaluated by</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">Inter/ Intra Institutional Workshop/ Training.</td><td>Excellent</td><td>80 to 100</td><td rowspan="24">(i) Student’s Diary and (ii) Internship Report along with the certificate issued from relevant authorised Authority</td><td rowspan="24">Institute Faculty (mentor) together with External Expert, if any.</td></tr>
<tr><td>Good</td><td>60 to 79</td></tr>
<tr><td>Satisfactory</td><td>40 to 59</td></tr>
<tr><td>Unsatisfactory and fail</td><td>< 39</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Working for consultancy/ Research project.</td><td>Excellent</td><td>80 to 100</td></tr>
<tr><td>Good</td><td>60 to 79</td></tr>
<tr><td>Satisfactory</td><td>40 to 59</td></tr>
<tr><td>Unsatisfactory and fail</td><td>< 39</td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">Festival (Technical / Business / Others) Events.</td><td>Excellent</td><td>80 to 100</td></tr>
<tr><td>Good</td><td>60 to 79</td></tr>
<tr><td>Satisfactory</td><td>40 to 59</td></tr>
<tr><td>Unsatisfactory and fail</td><td>< 39</td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">Contribution in Incubation/ Innovation/ Entrepreneurship Cell.</td><td>Excellent</td><td>80 to 100</td></tr>
<tr><td>Good</td><td>60 to 79</td></tr>
<tr><td>Satisfactory</td><td>40 to 59</td></tr>
<tr><td>Unsatisfactory and fail</td><td>< 39</td></tr>
<tr><td rowspan="4">5</td><td rowspan="4">Learning at Departmental Lab/Tinkering Lab/ Institutional workshop.</td><td>Excellent</td><td>80 to 100</td></tr>
<tr><td>Good</td><td>60 to 79</td></tr>
<tr><td>Satisfactory</td><td>40 to 59</td></tr>
<tr><td>Unsatisfactory and fail</td><td>< 39</td></tr>
<tr><td rowspan="4">6</td><td rowspan="4">Other than the above five activities</td><td>Excellent</td><td>80 to 100</td></tr>
<tr><td>Good</td><td>60 to 79</td></tr>
<tr><td>Satisfactory</td><td>40 to 59</td></tr>
<tr><td>Unsatisfactory and fail</td><td>< 39</td></tr>
<tr><td colspan="6">Note: The total CIE marks shall be the sum of marks allotted to successfully completed activities by the student.</td></tr>
</table>

3.6 Internship-II: (Societal internship and Research/Industry Internship) (08 weeks) [Scheduled during the intervening period of IV & V semester and VI & VII semester]

During the intervening period of IV & V semesters and VI & VII semester, students shall be ready for industrial experience. Therefore, they shall choose to undergo Internship involving Innovation / Entrepreneurship/short term (about 2 weeks) societal related activities. Students may choose to work on innovation or entrepreneurial activities, or both resulting in start-up or undergo internship with industry/ NGO’s/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.

3.6.1 Innovation

Innovation refers to a new or improved product or process or a combination thereof that differs marginally or significantly from the unit’s previous product. An innovation center is a place where students are encouraged to implement the innovative ideas formed through imagination, brainstorming sessions, design thinking and associated activities to bring them to reality. It is a place, where creative minds are shaped.

3.6.2 Entrepreneurship

Entrepreneurship refers to setting up a new business or businesses, taking on financial risks in the hope of profit. It involves investment to undertake production along with arranging inputs like land, labour, material and capital, introducing new techniques and products, identifying new sources for the enterprise, etc.

3.6.3 Incubation Center

An organized unit designed for innovation as well as to accelerate the growth and success of new entrepreneurial companies through mentorship and an array of business support resources and services that could include physical space, capital, coaching, common services, and networking connections.

3.6.4 Startup

An entity that develops a business model based on either product innovation or service innovation and makes it scalable, replicable and self-reliant.

An entity shall be considered as a Startup

i) Up to a period of ten years from the date of incorporation/ registration, if it is incorporated as a private limited company (as defined in the Companies Act, 2013) or registered as a partnership firm (registered under section 59 of the Partnership Act, 1932) or a limited liability partnership (under the Limited Liability Partnership Act, 2008) in India.
ii) Turnover of the entity for any of the financial years since incorporation/ registration has not exceeded one hundred crore rupees.
iii) Entity is working towards innovation, development or improvement of products or processes or services, or if it is a scalable business model with a high potential of employment generation or wealth creation.
iv) Provided that an entity formed by splitting up or reconstruction of an existing business shall not be considered a Startup.

3.6.5 Societal (Social) related activities

Short term internship (about 2 weeks) at villages, slums or urban areas can be under social internship. The internship will be more fruitful if students work in teams. The teams can select one or more fields to do their best in the field of agriculture, watershed management, wastelands development, non-conventional energy, low-cost housing, sanitation, nutrition and personal hygiene, schemes for skill development, income generation, blood bank, government schemes such as

i) (Swachch Bharat: Swachh Bharat Mission, Swachh Bharat Abhiyan, or Clean India Mission is a country-wide campaign to eliminate open defecation and improve solid waste management.
ii) Accessible India: Accessible India Campaign or Sugamya Bharat Abhiyan is a program to serve the differently able community of the country.
iii) Digital India: A campaign to ensure the Government's services are made available to citizens electronically by improved online infrastructure and by increasing Internet

connectivity or making the country digitally empowered in the field of technology.

iv) Beti Bachao and Beti Padhao: A campaign of the Government of India that aims to generate awareness and improve the efficiency of welfare services intended for girls in India.

v) Environment and Energy Conservation and Education, legal aid, consumer protection and allied field including Indian Red Cross Society, National Cadet Corps, Bharat Scouts and Guides.

Societal activities are one of the NBA graduate attributes that are part of PO6 and PO7, which are reproduced below.

vi) PO-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.

vii) PO-7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development. Long term goal under Societal (social work) related activities, particularly at a rural area, results into a rural internship. In urban areas, student may adopt slum/ economically weaker section areas for short duration social internship to uplift the living conditions.

In view of the above, internship coordinators should encourage students to take up societal internship as far as possible.

3.6.6 Places for Innovation/Entrepreneurial Activities

Students shall carryout Innovation or Entrepreneurial activities or both at the Incubation Center and Entrepreneurship Cell of the parent institution or elsewhere such as ATAL Incubation Centers [A flagship of Atal Innovation Mission (AIM), NITI Aayog for promoting the culture of innovation and entrepreneurship in India], institutes of national importance, public sector units, IT companies, government organizations, and non-governmental organizations, industries including MSME, etc.

- **Institutes should deter students to opt for internships at places established for commercial benefits.**

3.6.7 Industrial Internships

The gap between the theoretical knowledge obtained in the classrooms and the practical skills required in the actual workplace scenarios is fast growing. This has put forth varied challenges to graduating students when it comes to job placements. As institutes cannot have a relevant facility to expose students to real time industrial environment, industrial internship is an appropriate solution.

The main objective of the industry internship is to ensure that the intern is exposed to a real job world environment and gain practical experience. Often, it may be a practical exposure to the theory that has been learnt during the academic period. The industry internship helps student's understanding of the analytical concepts and tools, hone their skills in the real-life situations and build confidence in applying the skills learnt.

3.6.7.1 Industry Internship Benefits

i) Have ample opportunities to attend seminars, symposiums, workshops etc. This in turn provides opportunity to establish rapports with professionals and pioneers in their respective fields for further growth.
ii) Have wide scope to publish paper/s in journals.
iii) Good recommendation letter/s that increase prospectus for further internships, higher studies and placements.
iv) Helps to acquire team spirit, motivated acts, techniques to resolve conflicts, etc.
v) Helps to develop a lot of leadership skills.
vi) Increases the prospect of placement in the same concern, provided the intern has exhibited clear understanding of basics and successfully completed the internship.
vii) Fosters to substantiate the issues with facts and figures.

For AICTE Internship opportunities refer to https://internship.aicte-india.org/

3.6.8 Assessment Rubrics for Innovation / entrepreneurship/ Societal Internship Activities

Once the internship begins, the students are required to maintain diary/journal and submit a report regularly to the guide. These reports should summarize the activities in which the student was involved during the previous week period. At the end of the internship, each student is required to submit the hard copy of consolidated diary/journal and report for evaluation. The report should clearly indicate the learning and achievements of the internship.

Table – B3 Innovation / entrepreneurship/ Societal Internship Activities and Assessment Rubrics

Scheduled during the intervening period of IV & V semester and VI & VII Sem

(Prescribed Period 08 weeks: Credits 08)

Sub Activity Head	Performance/ Appraisal	Assessment Rubrics	Proposed Document as Evidence	Evaluated by
(1) Development of new product/ Business Plan/ registration of start-up/societal internship	Excellent	80 to 100	(i) Student's Diary and (ii) Internship Report or the activity report along with Certificate or Declaration from	(i) Institute Faculty (mentor) together with External Expert if any.
	Good	60 to 79		
	Satisfactory	40 to 59		
	Unsatisfactory and fail	< 39		
(2) Internship with Industry/ Govt. / NGO/ PSU/ Any	Excellent	80 to 100		
	Good	60 to 79		
	Satisfactory	40 to 59		

Micro/ Small/Medium Enterprise.	Unsatisfactory and fail	< 39	relevant Authorized Authority. Wherever, only Certificate is issued, Assessment shall be at the institute as per (i) and (ii) to	
Note: **(i)** The total CIE marks shall be the sum of marks allotted to successfully completed activities by the student.				

3.7 Research Internships / Extended Industry Internship

3.7.1 Research Internship /Extended Industry Internship of sufficient duration encourages students early on in their career. Its main goal is to give an opportunity to improve their analytical and technical skills in an international environment. Internship can be in an industry or at an appropriate workplace.

3.7.2 Research internships and industrial internships have different purposes and come with their set of benefits. A prior experience in any field is always preferred over a fresh start. Therefore, one of them can be selected depending on the interest the students have. Internships pose unexpected challenges and make students to think appropriately, tackle difficulties with ease and act in a scholarly way to get past the hurdles and practical constraints. An internship is always beneficial however good or bad it is.

3.7.3 Internships not only enhance one's learning but also identifies him/her as someone who has the commitment to approaching a project and completing it with or without the guidance. The internship learning is an impetus to professional development.

3.7.4 While research internship is a steppingstone to higher studies, an industry internship is a pathway for a placement. Those who are self-motivated and interested in search of new things that are original and unique can choose a research internship. Those who are interested in the real industry- experience and aspire to get a job soon after graduation can choose an industry internship.

3.7.5 Research Internships (Also known as dissertation internship) are focused research projects that push student's intellectual abilities beyond those driven by the classroom. Often, research internship typically helps solve problems which are usually part of major research projects. It involves a short theoretical or experimental research project supervised by a researcher.

3.7.6 The research internships, under the advice of a faculty supervisor, can be one's own selected project or a project on which a Researcher is researching or a new project/real – world project offered by an organization. The research area may be pertaining to single or multidisciplinary fields such as science, technology, engineering, mathematics, management, and business studies. Research internships can be carried out either individually or in teams (not exceeding 3 or 4 students).

3.7.7 Research internship opportunities, before graduation, may be in a laboratory of college, a research institute, or a company's R & D department. Apart from fixed working hours of the day of an organization, the researcher can devote sufficient time for other research related activities for an early and successful completion of the Research Internship.

3.7.8 Necessary Skills for Research Internship and Industrial Internship

For the internships to progress without hurdles and for successful completion, the Researchers should maintain a harmonious relationship with the guide/s, administrators, co – workers and others, and strictly adhere to the rules and regulations of the workplace. The other skills required or acquirable during the Internship are,

1. Good Communication skills.
2. Attention to detail.
3. Planning and scheduling.
4. Documentation.
5. Critical thinking.
6. Data collection.
7. Data analysis.
8. Ability to maintain quality, safety and/or infection control standards.
9. Appreciating and practicing the ethical issues.

3.7.9 Responsibilities of an Intern

Interns,

1. If working with a researcher, shall assist the researcher in an ongoing research project or work collaboratively in designing a new project of mutual interest.
2. Shall engage in literature survey and getting an insight of the research work at the initial stages.
3. Shall compile data, sort, file, implement ideas with minimal guidance and assist write papers.
4. Shall become familiar with a number of tools [meters (Electrical and Electronics, mechanical, computer, etc.)] used in data collection, software, graphic software, Statistical Package for the Social Sciences (SPSS) software [IBM's statistical software platform], etc.
5. Shall attain skills with Microsoft Word Office, Excel, PowerPoint, Outlook etc.
6. Shall give mid – term oral presentation to a committee for review and feedback.
7. Shall attend discussions, meetings, symposiums, classroom lectures, etc., to learn new scientific techniques, design experiments, analyze results, and formulate the different hypotheses.
8. Shall learn writing reports and be able to correspond independently.
9. Shall manage time effectively.
10. Shall keep a track of the progress of the project.
11. Shall develop integrative thinking.

3.7.10 Research internship Outcomes

1. Generating technical paper/s and publish in refereed journal/s.
2. Possibility of acquiring an intellectual ownership and patent.
3. Build a prototype for an idea on which the research was carried out.
4. File patent/s.
5. Add academic knowledge to the field.
6. Enhanced ability in arranging meetings, presentations, seminars, trainings, etc.

7. Improved conscientiousness and ethics

3.7.11 Research internships Benefits

1. Are a great way to pursue an academic career in teaching and research, as a Research Scientist at a Research Organization, Company, Industry sector, etc.
2. Establish professional networks for future career.
3. Pave way to join a research team and work alongside leading experts in the field.
4. Introduced to new ideas through interaction with like-minded students and others.
5. Develop research skills and knowledge in a specific area of interest.
6. Provide opportunities for growth, achievement, and personal development.
   Offer an opportunity to publish a research paper that will boost the resume while applying for Post Graduate Studies

4. Evaluation Procedure of UC3001-1 Research Internship /Extended Industry Project/Internship/Project work (16 weeks)

4.1 The students pursuing the course UC3001-1 shall submit the diary recordings of day-to-day activities to the concerned guide, reporting progress achieved in the course and seeking guidance to proceed with the internship. The interns should provide all the details to the guide, so that he/she can discuss with the employer to make the internship successful.

4.2 The intern should constantly update the guide about the progress of the internship. The guide should know the intern's internship tasks, duties, responsibilities, and potential projects. The evaluation of interns and their internship progress should be honest and constructive.

4.3 The hardcopy or softcopy of the diary maintained by the internes interns must be signed in regular intervals by the guide.

4.4 With reference to intern's feedback, the guides should propose changes in internship activities so that they are helpful to the internship.

4.5 Illustrations, drawings, photos, forms, samples, classified materials, etc., are to be included in the report only after obtaining the consent of the concerned authorities and should indicate the source all such material. The final report should also be submitted to the place where internship was carried out. The report should avoid a tone that is predominantly cynical or unduly critical of the employer or of those with whom the student intern has worked. The content of the report must be based on interns' own work.

4.6 Continuous Internal Evaluation (CIE)

The guides should evaluate the interns using the following as well as any other appropriate methods;

a) Punctuality of intern.
b) Conduct and character.
c) Tactfulness and politeness with colleagues and the public.
d) Attitude regarding professionalism.
e) Inquisitiveness and eagerness to learn.
f) Research attitude.
g) Problem-solving techniques.
h) Innovation mind-set.

i) Time management and meeting the deadline.
j) Receptiveness to feedback and critiques.
k) Ability to work in a team as a member.
l) Ability to work without supervision.
m) Supervisory skills and leadership skills.
n) Judgement and decision-making skills.
o) Writing skills, oral communication skills, technical communication skills, computer skills, analysis skills and business writing skills.
p) Appropriateness of technical skills.
q) Familiarization to writing technical papers, standards, codes, etc.
r) Reading Behavioural attitude.
s) Outcomes.
t) Successes and failures experienced

4.7 Recommendation letter

The guide must state whether the intern,

a) Exceeded the expectations of the internship.
b) Met the expectations of the internship.
c) Did not meet the expectations of the internship.
d) Did work to a satisfactory level.
e) Did an unsatisfactory internship.

At the end, the guide should issue a recommendation letter.

4.8 Assessment of CIE marks

4.8.1 **Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the internship, shall be based on the evaluation of the diary, presentation skill and viva-voce in the ratio 50:25:25.

4.8.2 **Interdisciplinary:** The CIE marks awarded for the internship, shall be group wise at the institution level with the participation of all guides of the internship. Participation of external guide/s, if any, is desirable.

4.8.3 The CIE marks awarded for the internship, shall be based on the evaluation of the diary, presentation skill and viva-voce in the ratio 50:25:25.

4.9 Assessment of SEE marks

4.9.1 Single discipline: Contribution to the internship and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department. Marks shall be awarded based on the evaluation of the report, presentation skill and viva-voce in the ratio 50:25:25.

4.9.2 Interdisciplinary: Contribution to the internship and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to. Marks shall be awarded based on the evaluation of the report, presentation skill and viva-voce in the ratio 50:25:25

4.10 Evaluation of research Internship/Extended Industry Internship/Project Work:

Split-up of marks for evaluation of Project work for 100 CIE marks and 100 SEE marks

Split up	Rubrics		Marks
Report **(50 Marks)**	Content Development	Abstract/ Synopsis Write-up	10
		Selection of Topic/ Relevance of the subject to concerned discipline	05
		Problem Identification	05
		Objectives and Methodology	05
	Problem-Oriented Exposition	Literature Survey (Papers/Sites/Sources Surveyed)	10
		Documentation/ Systematic Approach	10
		Results (with inferences, Conclusions, etc.)	05
Project Presentation Skill **(25 Marks)**		Quality of preparation of presentation	05
		Communication Skills	05
		Technical knowledge and awareness	05
		Individual involvement	10
Viva- Voce **(25 Marks)**		The clarity in answering questions relating to fundamentals and concepts	10
		The clarity in answering the questions related to the project	05
		The understanding ability of the questions asked	05
		The confidence in answering the questions asked.	05
		Total Marks	100

B. Tech. SYLLABUS

Effective from

Academic Year

2023 – 2024

Curriculum for Acquiring Professional Skills (CAPS)

With Scheme of Teaching & Examination

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Established under Section 3 of UGC Act 1956
Accredited with 'A+' Grade by NAAC

Off-Campus Centre, Nitte - 574 110, Karnataka, India

Scheme & Syllabus for
B. Tech. (Electrical and Electronics Engineering)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
2023-24

B. Tech. in Electrical and Electronics Engineering

Vision:

Pursuing excellence in Electrical & Electronics Engineering, creating a research environment to promote innovation and address global challenges

Mission:

- Equip students to face global challenges by excelling in a professional career and higher education
- Offer high-quality graduate and post graduate programs in electrical & electronics engineering
- Promote excellence in research, collaborative activities and contribute to social development with ethical values

Program Educational Objectives (PEOs):

To satisfy the mission of the Electrical & Electronics engineering program, the graduates will:

PEO1: Excel in professional career and / or higher education by acquiring knowledge in mathematical, electrical, electronics and computer engineering principles

PEO2: Analyze real life problems, design electrical and electronics & multidisciplinary engineering systems and solutions that are socially acceptable

PEO3: Inculcate and exhibit ethical values, communication skills and provide supportive and leadership roles in their profession to emerge as excellent professionals and adapt to current trends by engaging in lifelong learning to promote research

Program Outcomes (POs):

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: 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.

PO3: 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.

PO4: 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.

PO5: 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.

PO6: 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.

PO7: 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.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: 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.

PO11: 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.

PO12: 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 (PSOs):

PSO1: An ability to demonstrate the electrical and electronics engineering concepts by developing working models.

PSO2: Ability to model, simulate and develop application specific systems to meet industrial /societal needs.

B. Tech. in Electrical & Electronics Engineering

CREDIT DISTRIBUTION

No.	Course Category	Credit Range	Suggested Credits
1.	Basic Science Courses (BSC)	18-23	22
2.	Engineering Science Courses (ESC)	10-15	13
3.	Emerging Technology Courses (ETC)	03-05	03
4.	Programming Language Courses (PLC)	03-05	03
5.	Professional Core Courses (PCC)	52 - 58	55
6.	Professional Elective Courses (PEC)	12-18	15
7.	Open Elective Courses (OEC)	6	6
8.	Humanities, Social Sciences and Management courses (HSMC)	09-15	12
9.	Ability Enhancement Courses (AEC)	9	9
10.	Mandatory Non-credit Courses (MNC)	Non-Credit	0
11.	Holistic Education Courses (HEC)	2	1
12.	Vocational Education Courses (VEC)	1	1
13.	Project Work (PROJ) (UCC)	10-12	10
14.	Internship (INT) (UCC)	8-12	10
15.	Note: **Student can register between 16 to 28 credits per semester**		**160**
21.	**Total minimum Credits to be earned: 160**		

Course Numbering Scheme

<table>
<tr><th colspan="2">Branch Code</th><th>Course Level</th><th colspan="3">Course Code</th><th>Separator</th><th>Version</th></tr>
<tr><th>Letter</th><th>Letter</th><th>Number</th><th>Number</th><th>Number</th><th>Number</th><th>-</th><th>Number</th></tr>
<tr><td>Branch Code</td><td colspan="7">EE is 2 Letter code for the Department of Electrical & Electronics Engineering</td></tr>
<tr><td>Course Level</td><td colspan="7">Course Level is a 1-digit number that can have a value between 1-4 and indicates the prerequisite of a course.
Level-1 courses are basic courses with no courses as pre-requisites
Level-2 course(s) have Level-1 course(s) as prerequisites
Level-3 course(s) have Level-2 course(s) as prerequisites
Level-4 course(s) have Level-3 course(s) as prerequisites</td></tr>
<tr><td>Course Code</td><td colspan="7">Course Code is a 3 Digit number that can have a value between 001-999 and indicates the number assigned to a course based on the following guidelines

001-199 is assigned to Professional Core Courses
001-099 for Integrated Professional Core Courses [4 Credit]
101-199 for Professional Core Theory Courses [3 Credit]

201-499 for Professional Elective Courses
201-299 Electives under Group I
301-399 Electives under Group II
401-499 for future use

501-550 for Open Elective Courses

551 – 599 for Vocational Education Courses

601-650 for Professional Core Lab Courses [1 Credit]

651-699 for Ability Enhancement Courses

701-799 for Courses offered to Honours Program</td></tr>
<tr><td>Separator</td><td colspan="7">“-“ is used as a separator between the Course code and the version</td></tr>
<tr><td>Version</td><td colspan="7">Version is a 1-digit number that can have a value between 1-9 and indicates minor revisions of the same course.</td></tr>
</table>

Scheme & Syllabus
(I Year)

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

Group 2

I/II SEMESTER

Sl No.	Course and Course code		Course Title	Teaching Department	Teaching hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE	SEE	Total Marks	
					L	T	P					
1	BSC	MA1001-2	Matrix Algebra and Calculus	MAT	4	0	0	3	50	50	100	4
2	BSC	CY1005-1	Chemistry of Energy Storage and Display Devices	CHE	3	0	2	3	50	50	100	4
3	ESC	EE1001-2	Basic Electrical Engineering	EE	2	0	2	3	50	50	100	3
4	ESC	ME1003-2	Elements of Mechanical Engineering	ME	3	0	0	3	50	50	100	3
5	ETC	IS1101-1	Fundamentals of Cyber Security	EC	3	0	0	3	50	50	100	3
6	AEC	CS1651-1	IT Skills	Any Dept	1	0	2	3	50	50	100	2
7	AEC	BT1651-1	Biology for Engineers	BT	1	0	0	1	50	50	100	1
8	MNC	CV1002-1	Environmental Studies	CV	1	0	0	-	50	0	50	0
9	ESC	ME1004-1	Engineering Visualization	ME	0	0	2	-	50	0	50	1
				Total	**18**	0	**8**	**19**	**450**	**350**	**800**	**21**

Note:
BSC: Basic Science Course, **ESC**: Engineering Science Course, **HSMC**: Humanity and Social Science & Management Courses, **AEC** –Ability Enhancement Courses, **MNC**: Mandatory Non credited course **UM**: University Mandatory

MATRIX ALGEBRA & CALCULUS

Course Code:	**MA1001 - 2**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**4:0:0:0**	**Credits:**	**04**
Total Teaching Hours:	**50+0+0**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	This course will enable the students to master the basic tools of differential calculus, infinite series, elementary linear algebra, partial differentiation, multiple integration and become skilled for solving problems in science and engineering.

UNIT-I

Matrices	**10 Hours**

Elementary transformation of a matrix, Echelon form and rank of a matrix. Consistency and solution of system of linear equations; Gauss elimination method and approximate solution by Gauss Seidel method. Eigen values and eigen vectors of square matrices, Rayleigh's power method to find the largest eigen values and eigen vectors of square matrices.
Applications: Network Analysis, Markov Analysis, critical point of a network system, optimum solution.

UNIT-II

Sequences and Series	**10 Hours**

Convergence and divergence of infinite series. Tests for convergence of positive term series-comparison test, D-Alembert's ratio test and Cauchy's root test. Power series- Taylor's theorem for a function of single variable with remainder (without proof), expansion of functions into Taylor's and Maclaurin's series.
Applications: Series expansion in communication signals.

UNIT-III

Differential Calculus	**10 Hours**

Polar curves, angle between the radius vector and the tangent, angle of intersection of two curves. derivatives of arcs, radius of curvature - cartesian, parametric and polar forms. Rolle’s Theorem (without proof), mean value theorems and applications to simple problems.
Applications: Communication signals, Manufacturing of microphones, and Image processing.

UNIT-IV

Partial Differentiation	**10 Hours**

Partial derivatives of simple functions, total differentiation - differentiation of composite and implicit functions, Jacobians. Taylor’s theorem for functions of two variables, maxima and minima for functions of two variables, Lagrange’s method of undetermined multipliers (with one subsidiary condition).
Applications: Estimating the critical points and extreme values.

UNIT-V

Multiple Integrals	**10 Hours**

Double integrals and triple integrals, evaluation by change of order of integration, change of variables and applications to area and volume. Beta and Gamma functions and their properties.
Applications: Antenna and wave propagation, Calculation of optimum power in electrical circuits, field theory.

Course Outcomes: At the end of the course student will be able to

1.	Solve the system of linear equations and find eigen values and eigen vectors of the given matrix.
2.	Develop the power series of the given function and understand the concept of convergence and divergence of series.
3.	Apply the concept of radius of curvature and mean value theorems.
4.	Learn the concept of partial differentiation of a function with two or more independent variables, apply them to solve engineering problems and examine the given function for its extrema.
5.	Apply the notion of multiple integrals to find areas and volumes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA1001 - 2.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1001 - 2.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1001 - 2.3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MA1001 - 2.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1001 - 2.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.

2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.

REFERENCE BOOKS:

1. G.B. Thomas and R. L. Finney, "Calculus and Analytic geometry", Pearson, 2002.

2. T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.

3. B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.

4. N.P. Bali and M.Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/111107108/

2. https://nptel.ac.in/courses/122101003

CHEMISTRY OF ENERGY STORAGE AND DISPLAY DEVICES

Course Code:	**CY1005-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T:P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Chemistry

Course Objectives:

1.	To enable students to acquire knowledge on principles of chemistry for engineering applications.
2.	To develop an intuitive understanding of chemistry by emphasizing the related branches of engineering.
3.	To provide students with a solid foundation in analytical reasoning required to solve societal problems.

UNIT-I

Energy Conversion and Storage	**8 Hours**

Batteries: Introduction, classification of batteries. Components, construction, working and applications of modern batteries; Na-ion battery, Li-ion battery, and flow battery (Vanadium redox flow battery).
Fuel Cells: Introduction, construction, working and applications of methanol–oxygen and polymer electrolyte membrane (PEM) fuel cell.
Solar Energy: Introduction, importance of solar PV cell, construction and working of solar PV cell, Advantages and disadvantages.

Polymers	**7 Hours**

Polymers: Introduction, Molecular weight- Number average, Weight average and numerical problems. Elastomers – Definition, Synthesis, and applications of Butyl rubber and Silicone rubbers. Adhesives-Synthesis and applications of Epoxy resins. Polymer Composites: Introduction, synthesis, properties, and applications of carbon fiber. Conducting polymers– synthesis and conducting mechanism of polyacetylene. Preparation, properties, and commercial applications of graphene oxide.
PCB: Electroless plating – Introduction, Electroless plating of copper in the manufacture of double-sided PCB.

UNIT-II

Electrode System and Sensors	**9 Hours**

Electrode System: Introduction, types of electrodes. Reference electrode- Introduction, calomel electrode– construction, working and applications of calomel electrode. Concentration cell– Definition, construction, and Numerical problems. Ion selective electrode – definition, construction, working and applications of glass electrode. Determination of pH using glass electrode.
Sensors: Introduction, working principle and applications of Conductometric sensors, Electro chemical sensors, Thermometric sensors, and Optical sensors.

Corrosion chemistry and Analytical techniques	**6 Hours**

Corrosion Chemistry: Introduction, electrochemical theory of corrosion, types of corrosion- differential metal and differential aeration. Corrosion control-galvanization, anodization, and sacrificial anode method. Corrosion Penetration Rate (CPR) – Introduction and numerical problems.
Analytical techniques: Principle and instrumentation of Conductometry; its application in the estimation of weak acid and strong acid. Principle and instrumentation of Potentiometry; its application in the estimation of iron.

UNIT-III

Nanomaterials and Display Systems	**10 Hours**

Nanomaterials: Introduction, size dependent properties of nanomaterials (Surface area, Catalytic, Conducting), preparation of nanomaterials by sol-gel and co-precipitation method with example. Introduction, properties, synthesis, and applications carbon nano tubes.

Display Systems: Liquid crystals (LC's)-Introduction, classification, properties, and application in Liquid Crystal Displays (LCD's). Properties and application of Organic Light Emitting Diodes (OLED's) and Quantum Light emitting diodes (QLED's).

Perovskite Materials: Introduction, properties, and applications in opto-electronic devices.

E-waste Management: Introduction, sources, types, effects of e-waste on environment and human health, methods of disposal, advantages of recycling. Extraction of copper and gold from e-waste.

Suggested List of Experiments

1.	Determination of strength of an acid in Pb-acid battery (Demonstration).
2.	Determination of Total Hardness of a sample of water using disodium salt of EDTA.
3.	Estimation of iron in TMT bar by diphenyl amine/external indicator method.
4.	Synthesis of polyurethane (Demonstration).
5.	Conductometric estimation of strong acid with standard NaOH solution.
6.	Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution.
7.	Determination of pKa of vinegar using pH sensor (Glass electrode).
8.	Determination of the viscosity coefficient of a given liquid using Ostwald's viscometer.
9.	Estimation of Copper present in electroplating effluent by optical sensor (colorimetry).
10	Colorimetric determination of iron.
11	Conductometric estimation of a weak acid using standard NaOH solution.
12	Estimation of Sodium present in soil/effluent sample using flame photometer.
13	Synthesis of biodiesel (Demonstration).
14	Synthesis of Iron-oxide Nano particles (Demonstration).

Course Outcomes: At the end of the course student will be able to

1.	Identify the terms processes involved in scientific and engineering and applications.
2.	Explain the phenomena of chemistry to describe the methods of engineering processes.
3.	Solve the problems in chemistry that are pertinent in engineering applications.
4.	Apply the basic concepts of chemistry to explain the chemical properties and processes.
5.	Analyze properties and multi processes associated with chemical substances in disciplinary situations.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
CY1005-1.1	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CY1005-1.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CY1005-1.3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CY1005-1.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CY1005-1.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	P. C. Jain & Monica Jain, "Engineering Chemistry", Dhanpat Rai Publications, New Delhi, 2015.
2.	R. V. Gadag and Nityananda Shetty, "A Text Book of Engineering Chemistry", 2nd Edition, I. K. International Publishing house, 2016.
3.	S. S. Dara & S. S. Umare, "A Textbook of Engineering Chemistry", 12th Edition, S. Chand & Company Ltd., 2011.
REFERENCE BOOKS:	
1.	Baskar, "Wiley Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, 2013.
2.	Satya Prakash & Manisha Agrawal, "Engineering Chemistry", Khanna Book Publishing, Delhi.
3.	Bahl & Tuli, "Essentials of Physical Chemistry", S. Chand Publishing.
4.	Sunita Rattan, "Applied Chemistry", Kataria.
5.	D. Grour Krishana, "Engineering Chemistry – I", Vikas Publishing.
6	F. W. Billmeyer, "Text Book of Polymer Science", John Wiley & Sons, 4th Edition, 1999.
7	G. A. Ozin & A. C. Arsenault, "Nanotechnology A Chemical Approach to Nanomaterials", RSC Publishing, 2005.
8	Kirby W. Beard, "Linden's Handbook of Batteries", Fifth Edition, Mc GrawHill, 2019.
9	Takatoshi Tsujimura, "OLED Display Fundamentals and Applications", Wiley–Blackwell, 2012.
10	MaxLu, Francois Beguin, Elzbieta Frackowiak, "Super capacitors: Materials, Systems, and Applications", Wiley-VCH;1stedition, 2013.
11	H. Panda, "Handbook on Electroplating with Manufacture of Electro-chemicals", ASIAPACIFIC BUSINESS PRESS Inc., 2017.
12	Sudharani, "Laboratory manual in Engineering Chemistry", Dhanpat Rai Publishing Company, New Delhi.
13	"Expanding the Vision of Sensor Materials", National Research Council 1995, Washington, DC: The National Academies Press. doi:10.17226/4782.
14	Mahesh B and Roopa Shree B, "Engineering Chemistry", Sunstar Publisher, Bengaluru, ISBN978-93-85155-70-3, 2022
15	F. H. Froes,et al., "High Performance Metallic Materials for Cost Sensitive Applications", John Wiley & Sons, 2010.
16	K. R. Mahadik and L. Satyanarayana, "Instrumental Methods of Analysis", Nirali Prakashan, 2020.
17	Douglas A. Skoog, F. James Holler, Stanley R. Crouch, "Principles of Instrumental Analysis", Seventh Edition, Cengage Learning, 2020.
18	V R Gowariker, N V Viswanathan, Jayadev, Sreedhar, "Polymer Science", NewageInt. Publishers, 4th Edition, 2021.
19	Hari Singh, "Nanostructure materials and nanotechnology", Nalwa, Academic press, 1st Edition, 2002.
20	O. G. Palanna, "Engineering Chemistry", Tata McGraw Hill Education Pvt. Ltd. New Delhi, Fourth Reprint, 2015.
E Books / MOOCs/ NPTEL	
1.	http://libgen.rs/ • https://nptel.ac.in/downloads/122101001/
2.	https://nptel.ac.in/courses/104/103/104103019/ • https://ndl.iitkgp.ac.in/.
3.	https://www.youtube.com/watch?v=faESCxAWR9k

BASIC ELECTRICAL ENGINEERING

Course Code:	**EE1001-2**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P: S):	**2:0:2:0**	**Credits:**	**03**
Total Teaching Hours:	**25+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To familiarize the student with the DC circuit analyses.
2.	To analyze single and three-phase AC circuits.
3.	To understand the working principle of electrical machines.
4.	To introduce fundamental concepts in EV, basic converters and special motors, electrical wiring protective devices and safety measures

UNIT-I

Circuit Fundamentals:	**02 Hours**

Introduction to DC circuits, Basic nodal and mesh analysis excited by independent DC voltage sources, Power and Energy.

08 Hours

AC Fundamentals: Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities.

A.C. Circuits: Analysis of R, L, C, R-L, R-C and R-L-C series. Phasor Diagrams. Real power, reactive power, apparent power and power factor. Three-phase balanced circuits, voltage and current relations in star and delta connections. Measurement of three phase power using two wattmeter.

UNIT-II

DC Machines	**03 Hours**

Faradays Laws, self and mutually induced emfs. Constructional details, Principle of operation of generator and motor, Expression for back emf, Types of dc motors, Characteristic of dc motors (shunt and series motors only) and Applications.

Single-Phase Transformers:	**03 Hours**

Necessity of transformer, Principle of operation. Types of Transformers, Emf equation, losses, efficiency, problems on emf equation and efficiency, Autotransformer, Applications.

Induction Motors	**03 Hours**

Concept of rotating magnetic field, Construction and working of a three-phase Induction Motor, Slip and its significance, Torque slip characteristics (qualitative). Necessity of a starter, Principle of operation Single Phase Induction Motor. Applications

UNIT-III

Electric Vehicles:	**04 Hours**

Fundamentals, Block diagram of EV and its components. Motors used in EV – BLDC,Permanent Magnet Synchronous Machine (PMSM) -Working principle

SMPS: Concept of step up and step-down converter (Basic equation and Block diagram representation), Applications. Block diagram of UPS and applications.

Domestic Wiring:	**02 Hours**

Types of wiring. Two-way and Three-way control of lamp. Elementary discussion on Circuit protective devices: Fuse and Miniature Circuit Breaker (MCB's).

Personal safety measures: Electric Shock and Precautions against shock. Potential between neutral and ground. Necessity of Earthing, Earthing types- Pipe and Plate earthing.

*One additional tutorial class will be allotted every week

Suggested List of Experiments

1.	Verification of KVL and KCL for DC circuits.
2.	Measurement of current, power and power factor of incandescent lamp, fluorescent lamp, CFL and LED lamp.
3.	Sinusoidal steady state response of R-L, and R-C circuits- impedance calculation and verification
4.	Voltage and Current relationships of three phase star/delta circuits.
5.	Measurement of three-phase power using two wattmeter method
6.	Load test on a single-phase Transformer.
7.	Speed load characteristic of a 3-phase Induction Motor.
8.	Time characteristic of fuse

Demonstration Experiments

1.	Demonstration of fuse, MCB by creating a fault.
2.	Two-way and Three-way Control of lamp and formation of truth table.
3.	Demonstration of cut out sections of electrical machines (DC machines, Induction machines and Synchronous machines).
4.	Demonstration of EV and its Components.

Course Outcomes: At the end of the course student will be able to

1.	Analyze the DC Circuits using mesh & node methods to compute power and energy.
2.	Analyze voltage & current phasor relationships in single phase & three phase AC circuits to compute circuit parameters.
3.	Describe the fundamentals of electromagnetism, construction, operating principle of DC & Induction motor to study performance characteristics.
4.	Apply principle of single-phase transformer to compute transformer efficiency.
5.	Describe fundamental concepts in EV, converters, domestic wiring, protection and safety schemes

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE1001-2.1	2	3												

EE1001-2.2	2	3												
EE1001-2.3	2	3												
EE1001-2.4	2	3												
EE1001-2.5	2	3												

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 2010.
2.	Basic Electrical Engineering (with Lab Manual) | AICTE Prescribed Textbook by S.K. Sahdev (Author), January 2022
3.	Lecture Notes on Basic Electrical Engineering, Department of E&E, NMAMIT, Nitte. (New version)
4.	Electrical Technology, Hughes, Edward, Pearson Education Publications, 10th Edition, 2010.
5.	A. Chakarbarti, M.L. Soni and P.V. Gupta, U.S. Bhatnagar, Power system engineering, Published by Gagan Kanur, Dhanapat Rai and Co Pvt. Ltd,2013
REFERENCE BOOKS:	
1.	Electrical Engineering Fundamentals, Vincent Del Toro, 2nd Edition, Pearson, 2015
2.	Electrical Technology, H. Cotton, CBS; 7th Edition, 2005.
3.	Basic Electrical Engineering by A. Mittle and V. N. Mittle, Tata McGraw Hill, 2005
4.	Basic Electrical Engineering, Dr. Debashisha Jena, Wiley India Private Limited, 2012
5.	M.V. Deshpande, Elements of Power Station Design, 1st edition, PHI learning, 2009.
E Books / MOOCs/ NPTEL	
1.	http://nptel.ac.in/downloads/108105053/
2.	http://www.textbooksonline.tn.nic.in/books/11/stdxi-voc-ema-em-1.pdf
3.	Basic Electrical Technology Lectures by Dr. L Umanand Department of Power Electronics Group, CEDT IISC Bangalore available at http://www.nptelvideos.in/2012/11/basic-electrical-technology.html

ELEMENTS OF MECHANICAL ENGINEERING

Course Code:	**ME1003-2**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and processes.

1.	Understand the principles of energy sources, formation of steam and boilers.
2.	Know the working principles of pumps, compressors, and turbines.
3.	Understand basic principles of I. C. Engines, Refrigeration and Airconditioning.
4.	Understand the basic principles of power transmission and metal joining processes.
5.	Understand the different machining operations, automation, and robotics.

UNIT-I

09 Hours

Introduction to Mechanical Engineering (Overview only):
Role of Mechanical Engineering in Industries and Society- Emerging Trends and Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors. Biomaterials, Biomedical applications, implants, Additive manufacturing.

Simple stress and strain
Introduction, stress, strain, Mechanical properties of materials, Linear elasticity, Hook‟s Law and Poisson's ratio, Stress-Strain relation - behavior in Tension for Mild steel and nonferrous metals. Modes of heat transfer, Laws of Thermodynamics, Steam Formation and its application.

Energy Sources and Power Plants:
Basic working principles of Hydel power plant, Thermal power plant, nuclear power plant, Solar power plant, Tidal power plant and Wind power plant.

06 Hours

Pumps and compressors: Introduction, Working principles of Centrifugal Pump and Single Stage Reciprocating Compressor.
Turbines: Working principles of Impulse and Reaction steam turbines (De Laval and Parson's turbines), Water turbines (Pelton wheel, Kaplan, and Francis turbines), Gas turbines (Open and Closed cycles).

UNIT-II

09 Hours

Introduction to IC Engines: Components and working principles, 4-Stroke Petrol and Diesel engines, Application of IC Engines, performance of IC engines (Simple numericals).
Insight into future mobility technology; Electric and Hybrid Vehicles, Components of Electric and Hybrid Vehicles. Advantages and disadvantages of Electric Vehicles (EVs) and Hybrid vehicles.

Introduction to Refrigeration and Air Conditioning: Principle of refrigeration, Refrigerants and their desirable properties. Working principle of VCR refrigeration system, working principle of room air conditioner & Applications of air Conditioners.

06 Hours

Mechanical Power Transmission:
Gear Drives: Types - spur, helical, bevel, worm and rack and pinion, velocity ratio, simple and compound gear trains (simple numerical problems)
Belt Drives: Introduction, Types of belt drives (Flat and V-Belt Drive), length of the belt and tensions ratio (simple numerical problems)
Joining Processes: Soldering, Brazing and Welding, Definitions, classification of welding process, Arc welding, Gas welding, (types of flames), TIG welding, MIG welding and Fusion welding.

UNIT-III

10 Hours

Machine Tool Operations:
Lathe: Principle of working of a center lathe, lathe operations: Turning, facing, knurling, thread cutting, taper turning by swivelling the compound rest,
Drilling Machine: Working of simple drilling machine, drilling operations: drilling, boring, reaming, tapping, counter sinking, counter boring,
Milling Machine: Working and types of milling machine, milling operations: plane milling, end milling and slot milling.
(No sketches of machine tools, sketches to be used only for explaining the operations).
Mechatronics and Automation: Meaning, Need for automation, Types - Fixed, Programmable & Flexible automation. Elements of automated systems, Open and Closed loop control systems. Example of a simple pneumatic/ hydraulic/ electro-pneumatic circuit with function of each component.
Robotics: Introduction, Robot Anatomy, Classification based on Robot Configuration, Applications of Robots.

Course Outcomes: At the end of the course student will be able to

1.	Explain the principles of energy sources, formation of steam and Energy sources. And simple stress and strain.
2.	Discuss the working principles of pumps, compressors, and turbines.
3.	Explain basic principles of I. C. Engines, Future mobility and Refrigeration, Air conditioning
4.	Discuss the basic principles of power transmission and metal joining processes.
5.	Explain the different machining operations, automation, and robotics.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
ME1003-2.1	3	1	-	-	-	1	-	1	-	1	-	-	-	-	-

ME1003-2.2	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
ME1003-2.3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
ME1003-2.4	3	2	-	-	-	-	-	-	1	1	-	-	-	-	-
ME1003-2.5	3	2	-	-	-	-	-	1	1	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	K.R.Gopalkrishna, "A text Book of Elements of Mechanical Engineering" Subhash Publishers, Bangalore, 2010
2.	Mikell P. Groover, "Automation, Production Systems & CIM", 3rd Edition, PHI, 2012
3.	V.K. Manglik, "Elements of Mechanical Engineering", PHI Publications, 2013.

REFERENCE BOOKS

1.	S. Trymbaka Murthy, "A Text Book of Elements of Mechanical Engineering", 4th Edition 2006, Universities Press (India) Pvt. Ltd, Hyderabad.
2.	K.P. Roy, S.K. Hajra Choudhury, Nirjhar Roy, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt Ltd, Mumbai,7th Edition,2012.
3.	Pravin Kumar, "Basic Mechanical Engineering", 2013 Edition, Pearson.

E Books / MOOCs/ NPTEL

1.	https://nidm.gov.in/iec.asp (Study material of National Institute of Disaster management)

FUNDAMENTALS OF CYBER SECURITY

Course Code:	**IS1101-1**	**Course Type:**	**ETC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electrical and Electronics Engineering

Course Objectives:

1.	Define the area of cybercrime and forensics.
2.	Explain the motive and causes for cybercrime, detection, and handling.
3.	Investigate Areas affected by cybercrime.
4.	Illustrate tools used in cyber forensic

UNIT-I

Introduction to Cybercrime — **15 Hours**

Cybercrime - Definition and Origins of the Word, Cybercrime and Information Security, Who are Cybercriminals? Classifications of Cyber Crimes. [T1: 1.1-1.5]

Cyber offenses: How Criminals Plan Them

How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing. [T1: 2.1-2.8]

Mobile and Wireless Devices

Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops. [T1: 3.1-3.12]

UNIT-II

Tools and methods used in Cybercrime — **14 Hours**

Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan-horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks. [T1: 4.1-4.12]

Phishing and Identity Theft

Introduction to Phishing, Identity Theft (ID Theft). [T1: 5.1-5.3]

UNIT-III

Understanding Computer Forensics — **11 Hours**

Introduction, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Antiforensics. [T1: 7.1-7.19]

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the Cybercrime and its origin
2.	Analyse the cybercrimes in mobile and wireless devices
3.	Apply tools and methods used in Cyber crimes
4.	Analyse Phishing and ID Theft
5.	Comprehend Digital Forensics

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
IS1101-1.1	2	-	-	-	-	1	-	3	-	-	-	-	-	-	-
IS1101-1.2	-	3	-	1	-	2	-	-	2	-	-	-	-	-	-
IS1101-1.3	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-
IS1101-1.4	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
IS1101-1.5	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Sunit Belapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt Ltd, ISBN: 978-81-265-21791, Publish Date 2013.

REFERENCE BOOKS:

1.	Thomas J. Mowbray, "Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions", John Wiley & Sons, Inc, ISBN: 978 -1-118 -84965 -1, 2014.
2.	James Graham, Ryan Olson, Rick Howard, "Cyber Security Essentials'', CRC Press, 15-Dec 2010. Anti- Hacker Tool Kit (Indian Edition) by Mike Shema, Publication Mc Graw-Hill.
3.	Mr. Santosh BJ, Dr. K.V. S.S.S.S. Sairam, Mr. Shubham Kumar, Mr. Chandu Jagan Sekhar M, "Information and Cyber Security", Scientific International Publishing House, ISBN-978-93-5625-694-1.

IT SKILLS

Course Code:	**CS1651-1**	**Course Type:**	**AEC**
Teaching Hours/Week (L: T: P: S):	**1:0:2**	**Credits:**	**02**
Total Teaching Hours:	**13+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Any Department

Course Objectives:

1.	Demonstrate the basics of Android Programming.
2.	Design and develop effective static web pages.
3.	Describe the basic concepts of Cloud.
4.	Analyse data using Microsoft Excel.
5.	Create interactive gaming applications through Scratch coding.

Suggested List of Experiments

1. Design and create simple game using MIT-scratch/Code.org

- Design and create catch game using MIT scratch coding.
- Design and create a Jumping game using MIT scratch coding.
- Design and create pong game using MIT scratch coding.

2. Design and create simple android applications using MIT app inventor.

- Create an application to display a “Hello, World!” message on screen. Application should also display the current time and date.
- Implement an application to change the background colour and image of the screen.
- Create a simple calculator which can perform basic arithmetic operations like addition, subtraction, multiplication, or division depending upon the user input.
- Build a bouncing ball app or make a ball bounce around on the screen (on a Canvas).
- Write an application to send SMS using MIT app inventor and also implement a text-to-speech application by passing text from the user.

3. HTML and CSS

HTML: Basic Tags - paragraph, headings, Hyperlinks, image, tables, HTML forms.

4. HTML Lists: Unordered Lists, Ordered Lists and Definition list.

5. Create a form for a survey on the topic of your choice.Include a variety of answer options, including text fields, dropdowns, radio buttons, checkboxes, and a submit button. Use CSS to improve the look of your form.

6. Design and create web page for a travel book /recipe book with more than 3 pages, add table to list places /recipes (iframe, hyperlink)

7. Create user account and demonstrate use of Google drive, Google docs, Google Form.

- Upload and share any files and folders in google drive using different file permissions.
- Creation of google forms for applications such as a registration form, feedback form,quiz etc.
- Creation of google docs with citation from websites.

8.	**Data Analysis using Microsoft Excel.**
	• Basic Excel Formulas: Concatenate(),Len(),Days(), Net workdays(), Count(), Counta(), If(), Iferror(), Find(), Search(),Left(), Right() and Rank(). • Conditional Math: Learn to use SUMIF(), SUMIFS(), AVERAGE(), AVERAGEIF(), AVERAGEIFS(), COUNTIF(), COUNTIFS() to add cells only when certain conditions are met. • VLOOKUP with Approximate or Exact Match: Learn to use VLOOKUP to find an approximate or exact match and return the corresponding value, work with INDEX, MATCH, and HLOOKUP as alternatives to the VLOOKUP function. • Conditional Formatting: Apply the different rules to the values of the cell in sheets to carry out the analysis of data. • Optimizing Data: Sorting, Filtering, Excel PivotTables • Data Validation: Use Data Validation to ensure that users enter valid data in input cells, o restrict users' ability to enter invalid data in cells by providing them with a drop-down list of valid options. • Data Visualization in Excel-Charts by generating various types of charts.

Course Outcomes: At the end of the course student will be able to

1.	Develop Gaming Applications using Scratch Coding.
2.	Understand the basics of Android Programming.
3.	Design attractive and effective Static Web pages.
4.	Analyse the basic concepts of Cloud.
5.	Utilize Microsoft Excel to conduct data analysis.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
CS1651-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CS1651-1.2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CS1651-1.3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CS1651-1.4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CS1651-1.5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Suman M, Chinmaya Dash, R Sreenivas Rao "Digital Fluency", Himalaya Publishing House Pvt. Ltd., 2021.
2.	Melwyn Amrithraj, Prem Sagar, Pradeep, "Digital Fluency", Himalaya Publishing House Pvt. Ltd., 2021.
3.	R G Saha, Dr. Kantesha S, Niha Asif, "Digital Fluency", Himalaya Publishing House Pvt. Ltd., 2021.

REFERENCE BOOKS:

1	Randy Connolly and Ricardo Hoar, "Fundamentals of Web Development", 1st Edition, Pearson Education India.

E Books / MOOCs/ NPTEL	
1	https://www.sas.com/en_in/insights/analytics/machine-learning.html
2	https://www.aig.com/IoT
3	14 Types of Phishing Attacks That IT Administrators Should Watch For (syscloud.com)
4	6 Common Phishing Attacks and How to Protect Against Them (tripwire.com)
5	Important Applications of Cloud Computing (jigsawacademy.com)
6	Phishing Attack Prevention: How to Identify & Avoid Phishing Scams in 2021 | Digital GuardianIT Security FAQ (udel.edu)

BIOLOGY FOR ENGINEERS

Course Code:	**BT1651-1**	**Course Type:**	**AEC**
Teaching Hours/Week (L: T: P):	**1:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15+0+0**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Biotechnology

Course Objectives:

1.	To learn the types of cells, biomolecules, and life processes
2.	To know the applications inspired by nature in various streams
3.	To be updated application of biology in real life scenarios.

UNIT-I

Introduction For Biology for Engineers — **05 Hours**

Why Biology for Engineers? Cell Types & Properties: Prokaryotes - Bacteria, Viruses and Fungi, Eukaryotes - Plant and Animal Cells, Biomolecules, Life Processes at Cellular Level.

UNIT-II

Applications Inspired by Nature — **05 Hours**

Composites in Construction, Termite Mound architecture, Counter current heat exchangers, Design of aeroplane, helicopter and submarine, Information Theory and Biology, SONAR, Medical Devices.

UNIT-III

Real Life Scenarios — **05 Hours**

Recent scenarios in Environment, Agriculture and Medical Technology.

Course Outcomes: At the end of the course student will be able to

1.	Ascertain the importance of Biology to be applied in various engineering streams
2.	Interpret the basics of cell and life processes
3.	Draw inspiration nature in design of machinery and construction
4.	Analyze the significance of mimicry of nature in design of electrical, electronic, and medical devices
5.	Judge knowledge on recent advances in application of biology to Environment, Agriculture and Medical Technology

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
BT1651-1.1	3	-	-	-	-	-	-	-	1	-	-	1
BT1651-1.2	3	-	-	-	-	-	-	-	1	-	-	1
BT1651-1.3	3	3	-	-	-	-	2	-	1	-	-	1
BT1651-1.4	3	3	-	-	-	-	2	-	1	-	-	1
BT1651-1.5	3	3	-	-	-	-	2	-	1	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Suraishkumar, G. K., "Biology for Engineers", Oxford University Press India, 2019.

2.	Chakraborty, T, Akthar N., "Biology for Engineers", PHI learning, Print Book ISBN: 9789391818142 eBook ISBN: 9789391818197
REFERENCE BOOKS:	
1.	Rao C.V., "Biology for Engineers", 2021.
2.	Raven, P. H. and Johnson, G. B. "Biology", 4th Edition, WCB publishers, 2010.
3.	Ethier, R. S. and Simmons, C. A., "Introductory biomechanics- From cells to organisms", Cambridge University Press, 2012.

ENVIRONMENTAL STUDIES

Course Code:	**CV1002-1**	**Course Type**	**MNC**
Teaching Hours/Week (L: T: P)	**1:0:0**	**Credits**	**00**
Total Teaching Hours	**15+0+0**	**CIE + SEE Marks**	**50+00**

Teaching Department: Civil Engineering

Course Objectives:

1.	To raise consciousness about environmental conditions and to imbibe environmentally appropriate behaviour.
2.	To equip the engineering undergraduates to identify the significance of environmental practice in their daily life and in the engineering practices.
3.	To make them conscious of understanding the environment where we live and act up on.

UNIT-I

03 Hours

Environment

Definition, significance of environmental studies- current scenario, local, regional, national and global problems

Components of environment: atmosphere, hydrosphere, lithosphere, and biosphere. Layers of atmosphere and its role.

Parts of Earth- lithosphere and its role; hydrological cycle

Eco system - Definition, ecology and environment, ecosystem components: biotic and abiotic components; ecological balance; elements of ecosystem: biotic, abiotic; producers, consumers and decomposers.

Habitat, range of life, Biome, balanced eco- system, food chain, food web and ecological pyramids

Human activities - The Anthropogenic System- human activities like growing food, building shelter and other activities for economy and social security. Soil erosion, water logging - definition. Organic farming- definition.

Natural resources — **03 Hours**

Resources - Natural resources, water, minerals, Fossil fuels and energy

Water resources - Global water resources: distribution, uses of water for irrigation, domestic and industrial purposes in India.

Quality aspects - Water quality parameters, drinking water standards for turbidity, pH value, total hardness, iron, fluoride, lead, arsenic, nitrate

Mineral resources- Metallic minerals, non-metallic minerals Fossil fuels - Coal and petroleum

Forest Wealth - Components of the forest, key benefits of forests. Deforestation- environmental effects of deforestation and remedies Sustainable development- definition, objectives

Material cycles - Carbon, Nitrogen, and Sulphur cycles.

UNIT-II

Environmental pollution: Definition, harmful effects related to public health — **03 Hours**

Water pollution:
Definition, types, and sources – agriculture (pesticides and fertilizers), industry, domestic and mining, harmful effects, water borne and water induced diseases- definition, common diseases and their causatives, Fluoride problem in drinking water
Land pollution:
Definition, sources_ agriculture, housing, industry, mining, transportation. Types of municipal Solid waste Disposal (Sanitary landfills, composting, incineration (in brief) and effects
Air Pollution:
Definition, types, and sources: industry, mining, agriculture, transportation, and effects
Noise pollution:
Definition, sources, mining, industries, rail-roads, aviation, effects and control measures

Energy	**02 Hours**

Different types of energy-
Non-renewable energy; fossil fuels- coal, oil, and natural gas- brief description only. Nuclear energy- nuclear power plants,
Renewable energy: solar energy- Photovoltaic systems for street and domestic lighting, solar water heating-brief description only
Wind energy- definition, merits and demerits, Hydro power- definition, merits, and demerits. Biomass energy- definition, sources of bioenergy, biogas, biofuels, India's position in renewable energy
Hydrogen as an alternative future source of energy- brief scope, fuel cells.

UNIT-III

Current environmental issues of importance	**04 Hours**

Population growth- Definition, growth rate, effects, remedies Urbanization - Definition, environmental impacts and remedies Global warming and climate change-
Concept of greenhouse effect, sources of greenhouse gases, effects, and remedial measures of greenhouse gases
Acid rain: Definition, causes and effects, control measures. Ozone Depletion: Definition, causes, effects, and control measures.
Environmental Impact Assessment- EIA definition, objectives, and benefits of EIA.

Course Outcomes: At the end of the course student will be able to

1.	Identify the significance of environmental practice in their daily life and in the Engineering practices.
2.	Create awareness about environmental conditions.
3.	Follow environmentally appropriate behaviour.
4.	Understand the importance of their surroundings.
5.	Understand Current environmental issues of importance

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
CV1002-1.1	-	2	-	-	-	-	-	2	-	-	-	-	1	-	-
CV1002-1.2	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-
CV1002-1.3	1	-	-		1	-	-	-	-	-	-	-	1	-	-
CV1002-1.4	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-

CV1002-1.5	-	-	3	-	-	-	-	-	-	-	3	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Benny Joseph, "Environmental Studies", Tata McGraw Hill Publ. Co., New Delhi, 2005.
2.	Rajagopalan, R., "Environmental Studies: From Crisis to Cure", Oxford University Press, London, 2005.

REFERENCE BOOKS:

1.	Balasubramanya, N and Chatwal, Gurdeep R., "Environmental Studies", Himalaya Publishing House, Mumbai, 2007.
2.	Barucha, E., "Environmental Studies", University Grants Commission, New Delhi, 2004.
3.	Bhatia, S. C., "Environmental Chemistry", CBS Publishers, New Delhi, 2005.
4.	De, A.K. and De, A. K., "Environmental Studies", 2006.
5.	Keller, Edward A., "Environmental Geology", CBS Publishers and Distributors, Delhi, 1985.

ENGINEERING VISUALIZATION

Course Code:	**ME1004-1**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P):	**0:0:2**	**Credits:**	**01**
Total Teaching Hours:	**26**	**CIE + SEE Marks:**	**50+0**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To impart and inculcate understanding of the concept of orthographic projection and projection of plane surfaces and solids in different position in first angle projection system.
2.	To develop the lateral surfaces of solid objects and to draw the isometric projection of simple solids.

UNIT-I

02 Hours

Chapter 1: Orthographic Projection: Introduction to orthographic projection, Quadrants, principal planes, principal views, Difference between First angle and third angle projection, Dimensioning, Conventions employed for drawing.

06 Hours

Chapter 2: Projection of plane surface: Triangle, Square, Rectangle, Pentagon, Hexagon and Circle in simple position (Resting on HP with inclination to HP and VP, true length with true inclination only)

UNIT-II

06 Hours

Chapter 3: Projection of Solids: Prisms, Pyramids, Cones and Cylinders in simple position (Resting on HP with inclination to HP and VP, true length with true inclination only)
Orthographic projection of simple machine components using their isometric projection.

UNIT-III

06 Hours

Chapter 4: Development of Lateral surfaces of solids: Right regular Prisms, Pyramids, Cylinders and cones (with single section plane)

06 Hours

Chapter 5: Isometric projection: Isometric scale, Isometric dimensions, to draw Isometric views of simple solids and machine components using their orthographic projections.

Course Outcomes: At the end of the course student will be able to

1.	Draw the orthographic projections of a plane for a given position using Solid Edge software.
2.	Draw the orthographic projections of a solids and simple machine parts for a given position using Solid Edge software.
3.	Draw the development of lateral surfaces of standard solid objects. Draw isometric projection of solid objects individually or in combination using Solid Edge software.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
ME1004-1.1	3	1	-	-	-	-	-	-	1	1	-	2	2	1
ME1004-1.2	3	1	-	-	-	-	-	-	1	1	-	2	2	1
ME1004-1.3	3	1	-	-	-	-	-	-	1	1	-	2	2	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	N. D. Bhat & V. M. Panchal, Pramod R. Ingle, "Engineering Drawing", 53rd Edition, Charotar Publishing House, Gujarat, 2014.
2.	K. R. Gopalakrishna, "Engineering Drawing", Subhas publishers, Bangalore , 32nd Edition, 2012.

REFERENCE BOOKS

1.	"A Primer on computer aided Engineering Drawing", VTU, Belgaum, 8thedition, 2011.
2.	Shah, "Engineering Drawing and Computer Graphics", Pearson, 2010.
3.	Agarwal & Agarwal, "Engineering Graphics", TMH, Second edition, 2013.
4.	P. S. Gill, "A Text book of Engineering Graphics and Drafting", 11th Edition, S. K. Kataria & sons, New Delhi, 2009.

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

GROUP - 2

I/II SEMESTER

SI No.	Course and Course code		Course Title	Teaching Department	Teaching hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE	SEE	Total Marks	
					L	T	P					
1	BSC	MA1003-1	Differential Equations and Laplace Transforms	MAT	3	0	0	3	50	50	100	3
2	BSC	PH1006-1	Semiconductor Physics and Photonics	PHY	3	0	2	3	50	50	100	4
3	ESC	EC1001-1	Basic Electronics	EC	3	0	0	3	50	50	100	3
4	PLC	CS1004-1	Introduction to C Programming	EE	3	0	0	3	50	50	100	3
5	ESC	EC1002-1	Applied Digital Logic Design	EE	2	0	2	3	50	50	100	3
6	HSMC	HU1001-1	Technical English	HU	1	0	2	3	50	50	100	2
7	HSMC	HU1002-1	Constitution of India	HU	1	0	0	-	50	0	50	0
8	BSC	MA1006-1	Teaching Mathematics with MATLAB	MAT	0	0	2	-	50	0	50	1
				Total	**16**	**0**	**8**	**18**	**400**	**350**	**700**	**19**

Note:
BSC: Basic Science Course, **ESC**: Engineering Science Course, **HSMC**: Humanity and Social Science & Management Courses, **AEC** –Ability Enhancement Courses, **MNC**: Mandatory Non credited course **UM**: University Mandatory

Mandatory Internship-I*

1.	INT	UC1001-1	Internship – I	Mandatory Intra Institutional Internship of duration (80 - 90 Hours) to be completed during I & II Semesters. *The grades will be included in the IV semester grade card (Refer 11.5.2 for details)	100	--	100	2

DIFFERENTIAL EQUATIONS AND LAPLACE TRANSFORMS

Course Code:	**MA1003 - 1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	This course will enable the students to master the basic tools of Laplace transforms, differential equations, partial differential equations and become skilled for solving problems in science and engineering.

UNIT-I

First Order Ordinary Differential Equations	**08 Hours**

Exact, linear and Bernoulli's differential equations, orthogonal trajectories of cartesian and polar curves. Applications to simple engineering problems. Non-linear differential equations (first order and higher degree) equations solvable for p, equations solvable for y and equations solvable for x, general and singular solutions of Clairaut's equations.
Applications: Rate of growth or decay, conduction of heat.

Ordinary Differential Equations Of Higher Order	**08 Hours**

Second and higher order linear differential equation with constant coefficients, solution by inverse differential operator, method of variation of parameters, linear differential equation with variable coefficients- Cauchy's linear differential equation. Applications to engineering problems.
Applications: Oscillations of spring.

UNIT-II

Laplace Transforms	**08 Hours**

Definitions, transforms of elementary functions, transforms of derivatives and integrals-properties. Periodic functions, unit step functions and unit impulse functions.

Inverse Laplace Transforms	**08 Hours**

Inverse Transforms and properties, convolution theorem, initial & final value theorems. Applications to engineering problems.
Applications: Signals and systems, Control systems, LR, CR and LCR circuits.

UNIT-III

Partial Differential Equations	**08 Hours**

First and higher order partial differential equations. Formation of partial differential equations by elimination of arbitrary constants/arbitrary functions. Derivation of one-dimensional heat and wave equations, Solution of PDE's by direct integration method, by the method of separation of variables, by Lagrange's Method. Solution of partial differential equations of derivatives involving only one independent variable.
Applications: Propagation of heat or sound, fluid flow, elasticity, electrostatics, electrodynamics, thermodynamics.

Course Outcomes: At the end of the course student will be able to

1.	Solve first order ordinary differential equations.
2.	Solve linear ordinary differential equations of higher order.
3.	Understand the concept of Laplace Transform and apply it to solve engineering problems.
4.	Make use of Laplace transform method to solve linear ordinary differential equations with constant coefficients
5.	Understand the derivation of one dimensional heat and wave equations and solve partial differential equations.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA1003 - 1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1003 - 1.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1003 - 1.3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1003 - 1.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1003 - 1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.
2.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.

REFERENCE BOOKS:

1.	T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
2.	B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.
3.	N.P. Bali and M.Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.
4.	W.E. Boyce and R.C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", Wiley India, 2009.
5.	E.A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall India, 1995.
6.	G.F. Simmons and S.G. Krantz, "Differential Equations", McGraw Hill, 2007.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/111106100
2.	http://nptel.ac.in/courses/111106139
3.	http://nptel.ac.in/courses/111107111

SEMICONDUCTOR PHYSICS AND PHOTONICS

Course Code:	**PH1006-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L:T:P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Physics

Course Objectives:

1.	To understand the concepts of wave mechanics
2.	To study the concepts of quantum free electron theory.
3.	To understand the fundamentals of semiconductors.
4.	To study the concept of dielectrics.
5.	To understand the principles of lasers and optical fibers

UNIT-I

Wave Mechanics	**10 Hours**

Introduction, Matter waves and de Broglie Hypothesis, de Broglie wavelength and derivation of expression by analogy, Phase Velocity and Group Velocity, Wave Function, Physical significance of a wave function (Born Interpretation), Heisenberg's Uncertainty Principle, Schrodinger wave equation (time dependent and time independent), Eigen functions and Eigen Values, Particle in one dimensional infinite potential well, waveforms and probabilities. Numerical Problems.

Quantum Free electron theory	**05 Hours**

Classical free electron theory and its failures, Quantum Free Electron Theory of Metals - Assumptions, Fermi - Dirac Statistics, Fermi level, Fermi-energy, Fermi factor, Variation of Fermi Factor with Temperature and Energy, Numerical problems.

UNIT-II

Semiconductors	**8 Hours**

Introduction to semiconductors- intrinsic and extrinsic semiconductors - carrier generation, Direct and indirect band gap semiconductors.Fermi level in Intrinsic & Extrinsic Semiconductorand its behavior with temperature, Expression for concentration of electrons in conduction band & holes concentration in valance band (mention of the expression), Electrical conductivity of a semiconductor (derivation), Effect of temperature on conductivity of intrinsic and extrinsic semiconductors, Hall effect - theory with derivation for Hall coefficient, carrier concentration, andmobility, applications, Numerical problems.

p-n junction: Junction formation, Unbiased and biased p-n junction, Devices: LED, Photodiode and solar cell.

Dielectric materials	**7 Hours**

Dielectrics, Dipoles, Polar and non-polar dielectrics, Dielectric constant, Electric polarization, Polarizability, Electrical Polarization Mechanisms,Electric susceptibility (relation between P, χ and E - no derivation), Internal fields in solids(theory based on one dimensional atomic array), Clausius-Mossotti equation (Derivation), Temperature dependence of polarization, , Frequency dependence of polarization, Dielectric loss (derivation), Dielectric breakdown, Solid, Liquid and Gaseous dielectrics, Application of dielectrics in transformers, Capacitors and Electrical Insulation.

Ferroelectric materials and Piezoelectric materials, properties and applications, Numerical Problems.

UNIT-III	
Photonics: Lasers	**05 Hours**
Introduction to lasers, Characteristics of LASER, Interaction of radiation with matter, Einstein's coefficients, Expression for Energy Density and its significance. Requisites of a Laser System. Conditions for Laser action. Principle, Construction and Working of Nd:YAG and Semiconductor laser. Application of Lasers in Defence (Laser range finder), Barcode scanner and Laser Printer. Numerical Problems.	
Photonics: Optical Fibers	**05 Hours**
Introduction to optical fibers, Principle of optical fibers (TIR), Propagation mechanism in optical fibers - Angle of Acceptance and Numerical Aperture (N.A.), Expression for NA, Fractional Index Change, Modes of Propagation, Number of Modes and V Number, Types of Optical Fibers, Attenuation in optical fibers, Attenuation Spectrum - Optical Windows. Discussion of Block Diagram of Point-to-Point Communication, Intensity based Fiber Optic Displacement Sensor, Merits and Demerits, Numerical problems.	

List of Experiments (Any Ten experiments)

1.	Wavelength of LASER using Diffraction Grating.
2.	Numerical aperture of the given Optical Fiber.
3.	Energy gap of semiconductor by Four Probe Method
4.	Dielectric constant by charging and discharging of a capacitor.
5.	Hall effect
6.	Determination of Fermi Energy of Copper.
7.	Ferroelectric phase transition in Barium titanate
8.	Photo-Diode characteristics
9.	Solar cell characteristics
10.	Photo electric effect – Determination of the work function of the material of the emitter of a photocell.
11.	LED characteristics and determination of Planck's Constant using LEDs.

Course Outcomes: At the end of the course student will be able to

1.	Comprehend various properties of sub-atomic particles on the basis of wave mechanics.
2.	Elucidate the concepts of quantum free electron theory.
3.	Explain and analyze the properties of semiconductors.
4.	Describe and apply the concepts of dielectrics.
5.	Understand the principle, working and applications of lasers & optical fibers.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
PH1006-1.1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
PH1006-1.2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
PH1006-1.3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
PH1006-1.4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
PH1006-1.5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	Arthur Beiser, "Concepts of Modern Physics", Tata McGraw Hill Education Private Limited, Special Indian Edition, 2009.
2.	B. G. Streetmann, "Solid State Electronic devices", 6^{th} edition, Prentice Hall India Learning Private Limited.
3.	A. Ghatak, "Optics", Tata McGraw Hill Pub., 5^{th} edition, 2012.
REFERENCE BOOKS:	
1.	A. J. Dekker, "Electrical Engineering Materials", Prentice Hall India Pub., New Delhi, Reprint 2011.
2.	W. A. Wahab, "Solid State Physics, Structure and Properties of Materials", Narosa Publishing House Pvt. Ltd., New Delhi.
3.	Gupta and Kumar, "Solid State Physics", K. Nath & Co., Meerut
4.	M. Ali. Omar, "Elements of Solid State Physics: Principles and Applications", Pearson Publishers.
5.	S O Kasap, "Principles of electronic materials and device's", 4^{th} edition, McGraw Hill, 2017.
6.	M N Avadhanulu, P G Kshirsagar and TVS Arun Murthy, "A Textbook of Engineering Physics", S. Chand and Company Limited, New Delhi.
7.	Kenneth Krane "Modern Physics", Wiley International, 3^{rd} Edition, 2012.
8.	B. P. Pal, "Fundamentals of Fibre Optics in Telecommunication & Sensor Systems", New Age International Publishers
E Books / MOOCs/ NPTEL/ Web links	
1.	Laser: https://www.britannica.com/technology/laser,k
2.	Laser: https://nptel.ac.in/courses/115/102/115102124/
3.	Quantum mechanics: https://nptel.ac.in/courses/115/104/115104096/
4.	Physics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
5.	Numerical Aperture of fiber: https://bop-iitk.vlabs.ac.in/exp/numerical-aperture-measurement
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning	
1.	http://nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham
4.	https://vlab.amrita.edu/index.php?sub=1&brch=189&sim=343&cnt=1
5.	https://virtuallabs.merlot.org/vl_physics.html
6.	https://phet.colorado.edu
7.	https://www.myphysicslab.com

BASIC ELECTRONICS

Course Code:	**EC1001-1**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P):	**3:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To familiarize the student with Semiconductor devices like Diodes, Transistors and their applications
2.	To analyze the working of simple electronic circuits involving Op-amps, 555 Timer and Linear Regulator ICs.
3.	To understand the fundamentals of Modern communication system.
4.	To introduce the fundamentals of Embedded Systems

UNIT-I

Diodes and their Applications	**07 Hours**

Semiconductor Diode, Diode Equivalent circuits, Load Line analysis, Half Wave Rectifier, Full wave Bridge Rectifier, capacitor, and choke filter circuit (only qualitative approach). Zener Diode and its use in Voltage Regulation

Transistors and their Applications	**09 Hours**

Bipolar Junction Transistor: Construction and operation, Common Emitter and Common Base Characteristics, DC load line analysis, RC coupled amplifier (frequency response excluded), BJT as a switch, BJT circuit to switch ON/OFF an LED

Field Effect Transistor: Construction and Characteristics of JFET, Transfer Characteristics, Enhancement mode MOSFETs, CMOS Inverter.

UNIT-II

Op-Amp & Linear IC Applications	**11 Hours**

Introduction, Op-Amp Specifications, Differential & Common-Mode operation, Op-Amp applications: Inverting/Non-Inverting Amplifier, Summing, Integrator, Differentiator, Comparator. 555 Timer IC in Astable mode. 78XX series IC Voltage Regulators.

Feedback and Oscillator Circuits	**05 Hours**

Feedback– Principle and advantages of negative feedback, Voltage series feedback amplifier. Concept of positive feedback, Op-Amp Oscillators – RC phase shift, Hartley and Colpitts's Oscillator

UNIT-III

Fundamentals of Communication and Embedded Systems	**08 Hours**

Modern communication system scheme (Block scheme), Information source, Input Transducers, Transmitter, Channels, Receivers, Noise, Fundamentals of Cellular communication.

Embedded system definition, Embedded System v/s General Computing Systems, Classification of Embedded systems, Elements of Embedded systems, Core of Embedded systems, Microprocessor v/s Microcontroller, RISC v/s CISC, Hardware v/s Von Neumann Architecture, Sensors and Actuators with examples

Course Outcomes: At the end of the course student will be able to

1.	Explain the operation of Rectifiers; Design a rectifier circuit, given the specification for output Voltage, PIV, and ripple factor; Design a Zener voltage regulator for the given specification of output voltage and Power;
2.	Explain the construction and operation of Bipolar transistor in CE or CB Mode; Explain the use of BJT in Amplification as well as switching operations; Explain the construction and operation of JFET or MOSFET; Explain the operation of a CMOS Inverter;
3.	List the ideal and practical parameters for an Op-Amp; Define Op-amp Specifications; Explain the use of Op-Amp in Amplification, Summing, Integration, Differentiation and comparison; Design an Astable Multivibrator, using 555 Timer IC, for the given frequency and duty cycle;
4.	List the advantages and disadvantage of Negative Feedback; Explain the impact of negative feedback on Amplifier gain, Input and Output Impedance for a Series Voltage Negative feedback; Explain the operation of Op-Amp based RC Phase-shift, Hartley, and Colpitts Oscillator
5.	Explain the scheme of a Modern Communication System; List the differences between a general computing system and Embedded System; Describe the differences between Harvard and Von-Neuman, RISC and CISC system architectures

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
↓ Course Outcomes												
EC1001-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EC1001-1.2	3	-	-	-	-	-	-	-	-	-	-	-
EC1001-1.3	3	-	-	-	-	-	-	-	-	-	-	-
EC1001-1.4	3	-	-	-	-	-	-	-	-	-	-	-
EC1001-1.5	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, PHI, 2016
2.	Simon Haykin, "Introduction to Analog and Digital Communications", Wiley Publishers, 2nd Edition, 2019
3.	Theodore Rappaport, "Wireless Communications: Principles and Practice", Pearson, 2nd Edition, 2016
4.	Shibu K V, "Introduction to Embedded Systems", TATA Mc Graw Hill Edu., 2nd Edition, 2016

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/117107095
2.	https://nptel.ac.in/courses/117103063
3.	https://www.coursera.org/learn/electronics?#syllabus
4.	https://www.coursera.org/learn/diode-pn-junction-metal-semiconductor-contact?specialization=semiconductor-devices#syllabus
5.	https://www.coursera.org/learn/transistor-field-effect-transistor-bipolar-junction-transistor?specialization=semiconductor-devices

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2	3
CS1004-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CS1004-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CS1004-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CS1004-1.4	2	2	3	-	-	-	-	-	-	-	-	-	-	3	-
CS1004-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	E. Balaguruswamy, "Programming in ANSI C", Tata McGraw Hill, 3rd Edition, 2004.
2.	Jacqueline A. Jones & Keith Harrow, "C Programming with Problem Solving", Pearson,

REFERENCE BOOKS:

1	Kernighan & Ritchie, "The C Programming (ANSI C)", Prentice Hall; 2ndEdition, 1998.
2	Rajiv Khanna, "Computer Concepts and C Programming", New Age International Pvt Ltd Publishers, 1st Edition, 2006.
3	Yashwant Kanetkar, "Let Us C", 5th Edition, BPB Publications, New Delhi, 2004.

E Books / MOOCs/ NPTEL

1	http://www.lysator.liu.se/c/bwk-tutor.html#introduction
2	http://www.acm.uiuc.edu/webmonkeys/book/c_guide/
3	C programming Tutorial by Mark Burgers http://markburgess.org/CTutorial/C-Tut-4.02.pdf
4	http://nptel.ac.in/courses/106105085/4
5	https://www.lynda.com/C-training-tutorials/1249-0.html

INTRODUCTION TO C PROGRAMMING

Course Code:	**CS1004-1**	**Course Type:**	**PLC**
Teaching Hours/Week (L: T: P: S):	**2:0:2**	**Credits:**	**03**
Total Teaching Hours:	**26+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Make students learn the basics of C programming language including the basic data types, Operators and Evaluating expressions in C.
2.	Apply the concepts of decision making and looping in problem solving to demonstrate its usage using simple programs.
3.	Apply the concepts of Arrays, User-defined functions and code reusability in problem solving along with parameter passing and returning with the help of user defined functions.
4.	Demonstrate the usage of Strings andStructures
5.	Demonstrate the usage of Pointers, and File handling that are essential for understanding the concepts with simple examples.

UNIT-I

Introduction To C Programming Language	**10 Hours**
Basic C DataTypes, operators, Operator precedence, Arithmetic expressions and type conversion.	
Decision Making and Branching:	
Decision making with if statement, Nesting of if...else statements, ternary operator, the switch statement, the go to statement, break and continue statements.,	
Decision Making and Looping:	
The while statement, the do...while statement, the for statement, Jumps in Loops.	

UNIT-II

Arrays	**10 Hours**
Arrays (1-D, 2-D) Initialization and Declaration.	
User-Defined Functions	
Argument Passing – call by value, call by reference, Category of Functions. Managing Command line arguments Examples: Linear Search, Binary Search, Bubble sort, Selection Sort, Trace and Transpose, Matrix Multiplication.	
Strings	
Declaring and Initializing strings, String manipulation functions.	

UNIT-III

Structures	**06 Hours**
Structures and Unions: Usage and nesting, Array of Structures	
Pointers and File Handling:	
Accessing of variables using Pointers, array of pointers	

Basic file operations: Open, Close, Read, Write, Append and concatenate	
Suggested List of Experiments	
PART A	
9.	Write a C program to find the roots of a quadratic equation $ax^2+bx+c=0$
10.	Write a C program to find the sum of all the digits and occurrence of a digit in the number.
11.	Write a C program to find the GCD and LCM of given two numbers using Euclid's method.
12.	Write a C program to print the prime numbers in a given range.
13.	Write a C program to find if a given string is a palindrome or not using string manipulation functions.
14.	Write a C program to input N real numbers in 1-D array. Compute mean, variance and Standard Deviation. [Mean= sum/N, Variance = Σ (Xi-mean) 2 /N, STD Deviation= √variance.]
15.	Write a C program to read N integers into an array A and find the sum of elements using pointers.
16.	Write a C program to copy contents of one file to another file.
PART B	
1.	Write a C program to perform a binary search for a given key integer in a single dimensional array of numbers in ascending order and report success or failure in the form of a suitable message.
2.	Write a C program to input N integer numbers into a single dimension array, sort them in to ascending order using selection sort technique, and then to print both the given array and the sorted array with suitable headings.
3.	Write a C program to transpose a matrix of order M x N and find the trace of the resultant matrix.
4.	Write a C program using functions to read two matrices A (M x N) and B (P x Q) and to compute the product of A and B if the matrices are compatible for multiplication.
5.	Write a C program using functions readmat( ), rowsum ( ), colsum ( ), totsum ( ) and printmat( ) to read the values into a two dimensional array A, find the sum of all the elements of a row, sum of all the elements of a column, find the total sum of all the elements of the two dimensional array A and print the results.
6.	Write a C program to perform a linear search for a given key integer in a single dimensional array of numbers and report success or failure in the form of a suitable message using functions.
7.	Write a C program to enter the information like name, register number, marks in 6 subjects of N students into an array of structures, and find the average & display grade based on average for each student.

Average	**Grade**
80-100	Distinction

		60-79	First Class	
		40-59	Second Class	
		<40	Fail	
8.	Write a C program, to implement a bubble sort technique using function to sort given N integers in ascending/ descending order as per user's preference.			
9.	Write a program to demonstrate the use of pointers and files.			

Course Outcomes: At the end of the course student will be able to

1.	Describe the basics of C and the process of problem-solving aspects using algorithmic solution for a given problem. Apply the knowledge of expression solving to evaluate simple expressions and input/output statements to develop a C program.
2.	Develop the C program using control statements such as branching and looping constructs for a given problem.
3.	Apply the knowledge of code re-usability, parameter passing and returning values to develop a maintainable C program using these concepts including arrays and functions.
4.	Identify and describe the use of strings in a C program.
5.	Develop the C program using structures in C

APPLIED DIGITAL LOGIC DESIGN

Course Code:	**EC1002-2**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P)	**2:0:2**	**Credits:**	**03**
Total Teaching Hours:	**25+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the basics of Number Systems, Logic Gates and Boolean Functions.
2.	To understand simplification of the Boolean Equations using Boolean Algebra, Karnaugh Maps and QM method.
3.	To design combinational Logic Circuits like Adders/Subtractors, Binary Comparators, Decoders, Encoders, and Multiplexers.
4.	To understand the operation of Flip-Flops, Master-Slave Flip-Flops and Conversion of Flip Flops.
5.	To design Shift Registers and Counters.

UNIT-I

Fundamentals of Digital Design — **10 Hours**

Difference between Analog and Digital Signals, Number Systems: Decimal, Binary, Octal and Hexadecimal. Binary Addition and Subtraction, Digital Logic Gates, Boolean Algebra, Boolean Functions: Canonical Forms, Completely and Incompletely Specified Functions, Simplification of Boolean Functions using Boolean Algebra, Karnaugh Map and Quine-McCluskey Method, Realization of Boolean functions using Basic Gates and Universal Gates.

UNIT-II

Combinational Logic and Sequential Logic Circuits — **10 Hours**

Introduction to Combinational Logic Circuits, Half/Full Adders/Subtractors, Parallel Adders/Subtractors, Binary Comparators, Decoders, Encoders, Multiplexers.
Basic Bistable Element, SR Flip-Flop, D Flip Flop, JK Flip Flop, T Flip Flop, Master Slave JK Flip Flop, Characteristic Equations, Conversion of Flip Flops.

UNIT-III

Applications of Flip Flops — **05 Hours**

Design of Shift Register using D- flip flop, Design of Counters: Asynchronous counters using T-flip flop, Synchronous Counters using D-flip flop and T Flip Flop.

Suggested List of Experiments

1.	Introduction to Digital Circuit Simulation Software.
2.	Introduction to Basic gates, Universal gates.
3.	Realization of Logic Circuits using Universal gates.
4.	Realization of Combinational Logic Circuits.
5.	Realization of Sequential Logic Circuits.

Course Outcomes: At the end of the course student will be able to

1.	Compare Analog & Digital Signals; Convert the number from one numbering system to another; Analyze Boolean functions.
2.	Simplify the logic expressions using Boolean Algebra or K-Map or QM Method; Realize the logic expressions using Basic/Universal Gates.
3.	Analyze and Design different Combinational Logic Circuits such as Adders, Subtractors, Binary Comparators, Decoders, Encoders and Multiplexers.
4.	Describe the operation of Flip Flops, Mater-Slave Flip Flops and Conversion of Flip Flops.
5.	Make use of Flip Flops to design Shift Registers and Synchronous/Asynchronous Counters.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
EC1002-2.1	3	-	-	-	-	-	-	-	-	-	-	-
EC1002-2.2	3	1	1	-	3	-	-	-	3	1	-	-
EC1002-2.3	3	2	1	-	3	-	-	-	3	1	-	-
EC1002-2.4	3	-	-	-	3	-	-	-	3	1	-	-
EC1002-2.5	3	1	1	-	3	-	-	-	3	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Morris Mano, "Digital Design", Prentice Hall of India, 3rd Edition.
2. Donald D. Givone, "Digital Principles and Design", McGraw Hill, 2002.

REFERENCE BOOKS:

1. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2001.
2. D. P. Kothari and J. S Dhillon, "Digital Circuits and Design", Pearson, 2016.
3. Charles H Roth, "Fundamentals of Logic Design", Cengage Learning.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/117106086

TECHNICAL ENGLISH			
Course Code	**HU1001-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T:P)	**1:0:2**	**Credits**	**02**
Total Teaching Hours	**13+0+26**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Identify the nuances of Phonetics, Intonation and enhance pronunciation skills
2.	Understand Technical Communication along with the barriers and application of effective Interpersonal Communication Skills
3.	Enhance basic English grammar and essentials of language skills
4.	Improve sentence structure with the help of cohesive devices
5.	Develop spoken and writing skills

UNIT - I

Phonetics & Pronunciation	**8 Hours**
Introduction to Phonetics; Word Stress, Rhythm, and Intonation; Weak Forms and Strong Forms, Role of IPA in past tense and plural forms of words, Awareness of Different Accent	
Communication Skills	**8 Hours**
Introduction to Communication, Greeting and Introducing, Making Requests, asking for and Giving Permission, Offering Help. Understanding Telephone Communication, Handling Calls, asking for and Giving Information, Telephone Etiquette	

UNIT - II

Language Skills	**15 Hours**
Basic English Grammar, Ability to identify, Analyze, Interpret and Describe the critical ideas, values, and themes through literary works	

UNIT - III

Writing Skills	**8 Hours**
Paragraph writing, Refutations, Linkers, Types of Letters	

Course Outcomes: At the end of the course student will be able to

1.	Identify the nuances of phonetics, intonation and pronunciation to appreciate and incorporate Received Pronunciation
2.	Interpret and assess nuances of oral communication skills and the non-verbal communication for professional usage
3.	Identify, interpret and describe the critical ideas, values, and themes to appreciate literary pieces for its language and social interpretations
4.	Implement English vocabulary at command and language proficiency in personal and professional life
5.	Develop effective writing skills for incorporating them in different forms of writing

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1001-1.1	1	1	-	-	-	-	-	2	-	2	-	3	-	-
HU1001-1.2	2	-	-	-	-	2	-	-	-	3	-	3	-	-
HU1001-1.3	-	2	-	-	-		3	2	-	3	-	3	-	-
HU1001-1.4	-	2	-	-	-	2	-	-	2	2	-	2	-	-
HU1001-1.5	-	2	-	-	-	2	-	2	1	2	-	2	-	-

1: Low 2: Medium 3: High

TEXT BOOK:

1. Subhashini, "A Textbook of English Language & Communication Skills", R Victor et al.

REFERENCE MATERIALS:

1. English Pronunciation Dictionary, Daniel Jones A Remedial English Grammar for Foreign Students, Woods
2. Sanjay Kumar, "Communication Skills", Oxford University Press.
3. Exercises in Spoken English Part I - CIEFL, Hyderabad, Oxford University Press.
4. Exercises in Spoken English Part II - CIEFL, Hyderabad, Oxford University Press.
5. Exercises in Spoken English Part III - CIEFL, Hyderabad, Oxford University Press.
6. On Writing Well, William Zinsser
7. Practical English Usage, Swan, Oxford University Press.
8. Study Writing, Liz-Hamp Lyons, Cambridge University Press

E Resources

1. https://www.macmillandictionary.com/dictionary/british/

CONSTITUTION OF INDIA

Course Code	**HU1002-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T:P)	**1:0:0**	**Credits**	**01**
Total Teaching Hours	**15+0+0**	**CIE + SEE Marks**	**50+0**

Teaching Department: Humanities

Course Objectives:

1.	Inculcate Social and Political consciousness of the Indian Polity.
2.	Understand their Obligations, Responsibilities, Privileges and Rights, Duties, and the Role that they have to play in deciding the Administrative Machinery of the country.
3.	Develop National and Patriotic Spirit.
4.	Understand the nature and character of relations between union and state governments.
5.	Divulge the students about the statutory institutions and policies.

UNIT - I

Evolution of the Indian Constitution	**6 Hours**

1909 Act, 1919 Act, 1935 Govt of India Act, Constituent Assembly: Composition and Functions, Basic structure of Indian Constitution, Fundamental features of the Indian Constitution, Salient Features of Indian Constitution

UNIT - II

Structure of Government	**6 Hours**

Union Government: Legislature; Executive-President, Prime Minister, Council of Ministers; Judiciary, Judicial Review, and activism. State Government: Executive: Governor, Chief Minister, Council of Ministers.
Local Government: Panchayat Raj Institutions, Urban Governance

UNIT - III

Statutory Institutions	**3 Hours**

Elections - Election Commission of India, National Human Rights Commission, National Commission for Women.

Course Outcomes: At the end of the course student will be able to

1.	Analyze the legalities and related issues of drafting, adoption, and enforcement of the Indian Constitution as a fundamental law of the nation and the provisions and privileges of Indian Citizenship
2.	Understand and judiciously use the fundamental rights, fundamental duties and privileges envisaged in the constitution propagating social harmony and equality and respecting the rights and liberties of other people.
3.	Contribute in protecting and preserving the sovereignty and integrity of India and have a compassion to all living creatures, uphold sense of brotherhood ness among all citizens of the nation and promote peace and harmony
4.	Respect the Constitutional Institutions and all noble ideals cherished during Indian struggle for freedom

5.	Develop a Spirit of belongingness to the country.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO↓**	
↓ Course Outcomes													**1**	**2**
HU1002-1.1	-	-	-	-	-	-	-	3	-	-	1	1	-	-
HU1002-1.2	-	-	-	-	-	-	-	2	-	-	1	1	-	-
HU1002-1.3	-	-	2	-	-	-	1	2	-	-	1	1	-	-
HU1002-1.4	-	-		-	-	-	-	1	-	-	-	-	-	-
HU1002-1.5	-	-	1	-	-	-	-	3	-	-	1	1	-	-

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. Durga Das Basu, "Introduction to the Constitution of India", Twentieth Edition, LexisNexis Butterworths Wadhwa, Nagpur, Haryana, India, Reprint 2011.
2. M.V. Pylee, "Introduction to Constitution of India", Fourth Revised Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2005.
3. Brij Kishore Sharma , "Introduction to Constitution of India", Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
4. B. R. Venkatesh and Merunandan K. B., "An Introduction to Constitution of India and Professional Ethics", Merugu Publications, Bangalore; Second Edition, 2007.

E Resources

1. http://nptel.ac.in/courses/109104032/
2. https://pothi.com/pothi/book/ebook-ministry-law-and-justice-constitution-india
3. iasplanner.blogspot.com/2010/11/free-ebook-download-constitution-of.html
4. www.iasabhiyan.com
5. Samvidhaan, Documentary by Prasaar Bharathi

MATHEMATICS WITH MATLAB

Course Code	**MA1006-1**	**Course Type**	**BSC**
Teaching Hours/Week (L: T:P)	**0:0:2**	**Credits**	**01**
Total Teaching Hours	**0+0+26**	**CIE + SEE Marks**	**50+0**
Prerequisite	**MA1001-2 /MA1005-1**		

Teaching Department: Mathematics

Course Objectives:

1.	Understand the use of the basic operators, some built-in functions of MATLAB
2.	Create and work with arrays
3.	Create and display simple plots
4.	Solve by Symbolic and Numerical computation techniques

List of Experiments

1	Introduction to MATLAB: Basic Operators: Arithmetic, Logical and Relational operators. Elementary math functions such as algebraic, trigonometric, logarithmic, exponential functions, Conditions and Loops.
2	Symbolic Computation, plotting curves, surfaces and vector fields.
3	Computation of (a) eigenvalues and eigenvectors of a square matrix; (b) largest eigenvalue and the corresponding eigenvector of a square matrix; (c) rank of a square matrix
4	Solution of system of linear equations by Gauss elimination Method
5	Solution of system of linear equations by Gauss-Seidel method
6	Taylor's/ Maclaurin's series expansion of a function of single variable.
7	Computation of partial derivatives and Jacobians
8	Evaluation of double/triple integrals with constant/variable limits.
9	Computation of angle between (a) radius vector and tangent ; (b) two curves
10	Solution (with solution curve) of first order ordinary differential equation
11	Solution (with solution curve) of second and higher order linear differential equation with constant coefficients
12	Compute the roots of algebraic or transcendental equation using Regula-Falsi and Newton Raphson's Method.

Course Outcomes: At the end of the course student will be able to

1.	Write and compile simple MATLAB codes. Implement basic operators and conditions and loops effectively.
2.	Construct MATLAB programs gradually for the mathematics concept they are studying in theory.
3.	Appreciate the pictorial representation of the mathematics concept.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
MA1006-1.1	3	2	1	-	-	-	-	-	-	-	-	-	-	-
MA1006-1.2	3	2	1	-	-	-	-	-	-	-	-	-	-	-
MA1006-1.3	3	2	1	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. Rudra Pratap, “MATLAB”, OXFORD University press, 2010
2. Dorothy C. Attaway Ph.D, A practical introduction to prog. And problem solving , 5th edition

E Resources

1. https://www.mathworks.com › matlab › matlab_prog
2. https://www.coursera.org/specializations/mathematics-engineers
3. https://www.coursera.org/specializations/matlab-programming-engineers-scientists
4. https://www.coursera.org/learn/matlab

HOLISTIC COMPONENTS

HUMANITIES

Holistic education is not only about teaching the basic subjects, but it is more about redefining the way a student should be taught. The purpose of holistic language teaching is the development of the learners' ability to handle both their language oral skills as well as maximizing their life skills. The department contributes to educational life and work spaces that are creative and meaningful. Multidisciplinary and holistic learning is an ancient method used in Indian education system as well as the other parts of the world. This is the reason that such type of education system was advocated by scholars like Kautilya, Banabhatta, Plato, and Aristotle among many others. Holistic approach is essentially a student centered strategy rather than a teacher centered one.

Holistic education through courses allied to Humanities is created within the inclusive connections of social and human experience. A curriculum built around such stages is considered holistic if they involve the practices that integrates language acquisition and fills multiple cognitive demands in interlocking activities that spiral learning. Through the applied learning style of a person--mind, body and spirit students will learn more effectively the nuances of language, responsibilities towards social fabrics and ethics.

The approach strives to make a learner construct his own understanding of the text he/she interacts with and converses with others according his understanding. Intensive experiential and group sessions, a co-created learning ambience and hands-on engagement through real-life cases, field trips and internships to make learning exciting, rigorous and transformative. As a part of the holistic approach and its philosophy, a student is educated beyond core academics providing him/her virtuous and holistic education. This helps the students to discover their individuality and comprehend the significance of life purposefully, creatively, and morally in a complex world. Krishnamurti writes If the unity of life and the oneness of its purpose could be clearly taught to the young, how much brighter would be our hopes for the future! (Krishnamurti, J. 1974).

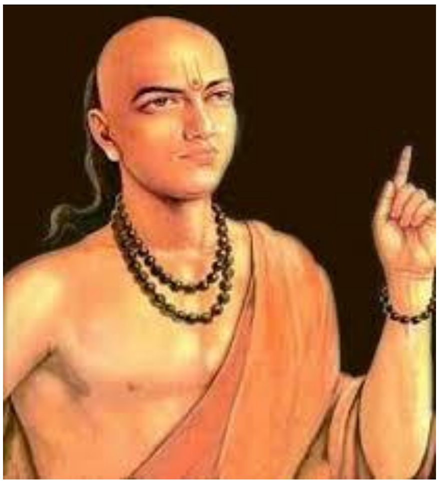
MATHEMATICS

INDIAN MATHEMATICIANS

It is essential to know about the ancient, medieval and modern time Indian mathematicians and their contribution to Science and Mathematics. Ancient Indian mathematicians have contributed immensely to the field of mathematics. The invention of zero is attributed to Indians and this contribution outweighs all other made by any other nation since it is the basis of the decimal number system, without which no advancement in mathematics would have been possible. The number system used today was invented by Indians and it is still called Indo-Arabic numerals because Indians invented them and the Arab merchants took them to the western world.

Here we are introducing some of the important Indian mathematicians from ancient times.

Aryabhata: (500 A. D.) - Studied at the University of Nalanda, which was considered as a great centre of learning. Aryabhata was a great Indian mathematician. He gave the value of "π" as 3.1416, claiming for the 1st time, that it was approximation. Aryabhata also dealt with other aspects of mathematics and Astronomical calculations, namely Geometry, Mensuration, Square root, Cube root, Progression and Celestial sphere. He presented a method to solve an intermediate equation of certain type that are important in astronomy and computer science.



Bhaskara : (1100 A. D.) - was a great Mathematician and Astrologer. He was the first Mathematician to declare confidently that any term divided by ZERO is infinity and the sum of any term and infinity is infinity. His concept of "Tatkalikagati", which means instantaneous motion, used by astronomers to determine the motion of the planet accurately brought credit to him. He explained the solutions of quadratic and cubic equations. He stated the Rolle's theorems in analysis, the mean value theorem.

Srinivas Ramanujan was an Indian Mathematician who made significant contributions to mathematical analysis, Number theory and continued fractions. He made many important contributions in the field of mathematics with his wonderful and unique knowledge. That's why his birthday is celebrated as Mathematics Day.

PHYSICS

The ancient world had considered Physical Sciences, Chemical Sciences, Earth Sciences, Biological Sciences, Mathematical Sciences etc. as study of nature, which were all studied under the banner of Philosophy. Even today, the philosophers are studying Metaphysics which connects physical attributes to mind. Physics is a branch of science which deals with the study of matter and energy. The Physical Science was a matter of interest for all the civilizations including Vedic era of India dating back to over 3000 years. The physical science in ancient India was majorly restricted to Astronomy and Astrology. It was **Kanada**(600 B.C.) who presented holistic approach of physics, by blending science, philosophy and religion through 'Vaisesika Sutra'. Their essence is the atomic theory of matter. He gave the name 'Paramanu' (Atom), to be the indivisible entity of matter. The idea of chemical change was also put forward by Kanada. Bharadwaja is credited with teaching missile technology. Aryabhata(500 A.D.) was a great astronomer. He was the first to state that the earth is round and it rotates on its own axis, creating day and night. He declared that the moon is dark and shines only because of sunlight. Aryabhatta contributed greatly to the field of science particularly astronomy. Varaha mihira (500 A.D.) studied astrology and astronomy and declared that the earth was spherical. He also proposed that the moon and planets are lustrous not because of their own light but due to sunlight. Bhaskra (1100 A. D.) was a great scientist his concept of "Tatkalikagati", which means instantaneous motion, used by astronomers to determine the motion of the planet accurately brought credit to him. Brahmagupta(598 A.D.) calculated the instantaneous motion of a planet, gave correct equations for parallax, and some information related to the computation of eclipses and is widely regarded as one of the most accomplished of the ancient Indian astronomers.

"If you wish to make an apple pie from scratch, you must first invent the universe."So said astronomer Carl Sagan in an episode of his landmark television series, Cosmos. Embedded in Sagan's memorable quip is a certain holistic understanding of the universe — a notion that the existence of any one thing is intimately tied to the existence of everything else. There are no apple pies without apples; there are no apples without the proper climate for growing apple trees; there is no proper climate for growing apple trees without a planet on which the apple trees can grow — and so on, all the way back to the Big Bang.Pythagoras and his followers held mathematics in an almost holy regard, and they saw numbers as a basic form of matter. According to their view, all things had numbers, and the objects of the universe — including human societies — were arranged in harmonious mathematical relationships with one another.

All sciences were originated from philosophy. Physics was called natural philosophy until the 19th century, but once it was proven to be correct it was no longer philosophy and became a science. Physics is the science of the natural world, more specifically dealing with the matter, energy, space-time, and fundamental forces that govern the physical world. In physics we study a wide range of physical phenomena from subatomic particles to large galaxies of the material universe, and use empirical data and mathematics to find results and conclusions. Physics is also deeply concerned with arriving at knowledge about the ultimate nature of reality. Since we cannot know whether we have discovered everything which would affect our theories of the universe, all such theories are perpetually subject to modification or change. Mathematics is a language and a tool that we use in physics to explain the universe. Quantum physics is a mathematical description that rules the tiny world of atoms and subatomic particles in our universe. Without quantum physics, much of the information technology that we rely on, from microcircuits to lasers, would not exist. Today many scientists argue that metaphysics plays an important role in quantum mechanics at a deeper level; the nature of reality is all mathematical. This could be an example of how metaphysical assumptions can get in the way of our understanding the paradoxical nature of quantum mechanics. But even when quantum mechanics appears a mystical science of metaphysics, it is not metaphysics but productive science.

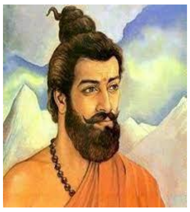
Thus, the Physics though has many branches and uses many other branches of science and philosophy, in the past and the present, its aim is to understand the whole universe which is nothing but matter and energy which is seen or unseen.

CHEMISTRY

ANCIENT SEERS OF INDIA – CHEMISTRY

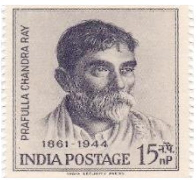
In ancient India, chemistry was called **Rasayan Shastra, Rasa-Vidya, Rasatantra and Rasakriya** all of which roughly mean '***Science of Liquids***'. There also existed chemical laboratories which were called **Rasakriya-nagaram/Rasakriya-shala**, which literally mean '***School where liquids are activated***'. Rigveda (earlier than 1500 BCE) mentions many fermented drinks and methods of fermentation, apart from various metals. Soma juice from the stems of the soma plant was considered a divine drink. The Vedic Indians were acquainted with the art of dyeing with certain natural vegetable colouring matters. A type of pottery, now known as 'Painted Grey Ware', is also associated with the Vedic period.

Ancient chemistry in India grew out of the early efforts to develop an elixir; to turn base metals into gold and on metallurgy. Chemical techniques in India can be traced back all the way to the Indus valley or Harappan civilisation (3rd millennium BCE). Pre-Harappan Indians were acquainted with the art of making baked or burnt clay pottery as well as painting the same with two or more colours (by addition of iron oxide, manganese oxide, etc.). Kautilya's Arthashaastra (3rd or 4th century BCE) has a lot of information on prevailing chemical practices. Apart from mines and minerals, it discusses the details of precious stones (pearl, ruby, beryl, etc.); preparation of fermented juices (sugarcane, jaggery, honey, jambu, jackfruit, mango, etc.) and oil extraction.



It is said that **Maharshi Kanada** was the first to propound that the *Parmanu* (atom) was an indestructible particle of matter and that Universe is made up of *Kana*. When matter is divided and sudivided, we reach a stage beyond which no division is possible, the undivisible element of matter is *Parmanu*. Kanada explained that this indivisible, indestructible y cannot be sensed through any human organ.

Nagarjuna (931 A.D.) from Somnath in Gujarat was a chemist/alchemist, who concentrated his efforts in transforming the base metals into gold. His reputation was such that people believed Nagarjuna to be in communion with gods and goddesses who had blessed him with the power of changing base metals into gold and extracting the 'elixir of life'.



Prafulla Chandra Ray (1861-1944), an Indian chemist, is often referred to as the Father of Chemistry in India. He received his BS in 1882 and his PhD in 1887 from University of Edinburgh. In 1896, he announced a major discovery of a new compound, mercurous nitrite.

Today's Science and Technology has been greatly inspired by the contributions of these wise seers. Indians have continued to show their global impact in the Field of Science. In the 21st century, biochemist **Har Gobind Khorana** won the Nobel Prize (1968) for demonstrating how the nucleotides in nucleic acids control the synthesis of proteins.

Thus, the seers of ancient India have contributed significantly in the development of Modern Chemistry.

BIOTECHNOLOGY

Biology for Engineers

Science deals with matter. It is based on starting from scratch with what a human can observe, test, and rationalize. Ancient sages have worked hard to be seen as the only reliable providers of knowledge to the world. In 1875, the Vymaanika Shaastra, a 4th Century BC text written by Sage Bharadwaj was discovered in a temple in India. It contains 3000 shlokas in 8 chapters which was physically delivered by the ancient Hindu Sage Bharadwaj. The book greatly deals with the operation of ancient vimanas and included information on steering, precautions for long flights, protection of the airships from storms and lightning and how to switch the drive of solar energy or some other form of energy. One of the chapter will reveal the secrets of constructing aeroplanes that cannot be broken or cut, that is indestructible, that is fire resistant. It also deals with the secret of making planes motionless and invisible. It also describes how to defeat the enemy planes etc. as per the Sage Bharadwaj the vimanas were classifies as per the Yugas. During the period of Krita Yuga, Dharma was establishes firmly. The pushpak Vimana which was used by Ravan was an Aerial vehicle. He used this vehicle to kidnap Sita from jungle and took him to his Kingdom Srilanka. Ramayana was during the Treta Yug in which the Vimanas were highly discovered. During this period "Laghima" gave them the power to lighten their vehicle do they can travel freely in the air.

COMPUTER AND INFORMATION SCIENCE

The Indians (**Aryabhata**, 476 BC - 550 BC) contributed **Zero (0)** to the number system**.** So that numeric system and computing world found an ease in solving numerical problems using computer programs.

Acharya **Pingala** was an ancient Indian mathematician who lived around 300 BCE. He wrote the Chandaḥśāstra, where he analysed **Sanskrit poetry mathematically**. It also contained the first known explanations of **digit zero**, **binary numbers, Fibonacci numbers and Pascal's triangle**.

Baudhayana (8th century BCE) composed the Baudhayana Sulba Sutra, which contains examples of Pythagorean triples, such as: (3,4,5), (5,12,13), (8,15,17), (7,24,25) and (12,35,37) as well as a statement of the Pythagorean theorem for the sides of a square: "The rope which is stretched across the diagonal of a square produces an area double the size of the original square."

In Indian astronomy, the study of **trigonometric functions** flourished in the Gupta period, especially due to **Aryabhata (sixth century CE),** who discovered the **sine function**.

Quadratic equation of the form $ax^2 + bx + c = 0, a \neq 0$ and is given by $x = (-b \pm \sqrt{(b^2 - 4ac)}) / 2a$. was discovered by **Sridharacharya** in the 11th century.

The largest numbers the Greeks and Romans used were 106. In 5000 BC **Indians used numbers as big as 10^{53}** (10 to the power 53) with specific names. The largest used number today is **Tera 10^{12}**.

Kaṭapayadi numerical notation is an ancient Indian system to depict letters to numbers for easy remembrance of numbers as **words or verses**.

For example: □(Ka)=1 □(Ka)=2 □(Ga)=3 □(Ga)=4 □□(Gnya)=5 □(Cha)=6 □(Cha)=7 □(Ja)=8 □(Ja)=9 □(Nya)=0. The modern **Hasing technique in computing system** which is resembling was then being used in the **Indian Katapayadi system**. For example, the hashing number based on Katapayadi system would be as follows for '**Gurudev'**

Gu=Ga(is the consonant)=3, Ru=Ra(is the consonant)=2, De=Da(is the consonant)=8 Va=Va(is the consonant)=4, So Gurudeva = 4823.

In the recent decades, following are the few of the major contributors to the computing world:

- In 1996 the USB port invented by the Ajay Bhatt, an Indian at Intel Oregon which involved low level programs delt with embedded C Language to perform flexible IO transfer and opened up an area to use plug-and-play devices efficiently.
- The Pentium chip invented by Vinod Dham, that made C compiler to speed up the program execution and do well with GUI applications (both System and User Level) that are wiritten in C language.

  Amit Singhal is an Indian who rewrote (search engine in 2001) the google algorithm (C language coding embedded with Assembly Language service routins in Windows and Unix/Linux). Then on the Google processes over 40,000 search queries every second on average which translates to over 3.5 billion searches per day and 1.2 trillion searches per year worldwide.

Few of the contribution as Auther of CP and Educators of C language:

1. Yashavant Kanetkar is an Indian computer science author, known for his varieties of C Programming books.
2. E. Balagurusamy : An Computer scientist known for Programming in ANSI C

ELECTRONICS AND COMMUNICATION ENGINEERING

The idea of a holistic approach to engineering design and education has been envisioned to meet the perceived and emerging needs for innovation in the 21st century. Many engineering educators, practicing engineers and engineering students have already recognized the gaps and areas of potential improvements in the knowledge acquisition process implemented in current engineering degree programs when compared to current societal and technological issues and developments.

Society and humanity have progressed drastically over the past few generations. Engineers as a network of professional problem solvers have been heavily involved in these global communities and the engineering profession is evolving from one that focuses on targeted, isolated issues, to one that embraces challenges that incorporate physical, economic, environmental, and humanitarian aspects.

Currently, engineering students are required to take classes on ethics, liberal studies and technology and society courses, however engineering students are not prefaced with the importance of rounding out their education with these topics, and while social issues are discussed, they are not related to engineering specifically. That being said, explicitly linking the technical aspects of engineering to society is paramount in training effective problem solvers for the 21st century. With some exposure to multi-disciplinary, inter-disciplinary and trans-disciplinary approaches to engineering and design, students will be better prepared for their future careers in industry or research fields.

The functional requirements for the perceived solution were determined by the expected outcomes and what students should take away after experiencing the new educational product. Some of them are:

- students will be inspired and driven to seek opportunities in engineering for environmental, social, medical, and human development/poverty issues.
- students will be able to identify the issues that are emerging from new technology, how to mitigate the negative aspects and reduce the amount of impact, while leveraging the positive outcomes.
- students will have respect and knowledge of the importance of ethics and policy matters in the field of engineering and be able to determine between unethical and an ethical situation in a proactive manner.

The courses should overcome the challenges of the current engineering educational system. Approaching the degree from a holistic perspective. The integrated system that fosters collaboration among faculty and students. A new organizational and pedagogical model, which emphasizes knowledge integration and interweaves thematic content threads throughout the curriculum should be proposed.

- Foundations thread (math and science) Key mathematical concepts lay the foundation for understanding the anchoring concepts in courses throughout the ECE curriculum. The foundations thread unpacks mathematics and physics concepts to help students learn fundamentals in ECE topics like circuits, signals and systems, and electromagnetics. The foundations thread champion spearheads the collaboration between the math and ECE departments to introduce and promote the value and utility of mathematics in ECE courses, as well as the importance of mathematical thinking.

- Creativity thread (research, design, and optimization tools) The creativity thread is intended to integrate research and design throughout the undergraduate experience. By showing the impact of research, students will see the practical applications and potential breakthroughs of fundamental ECE concepts. Likewise, exposing students to design at every level of the undergraduate experience allows them to experience the excitement of engineering by applying their foundational knowledge to a tangible product.
- Professional formation thread (communications, cultural adaptability, ethics, leadership, and teamwork) Partnering with faculty and industry leaders to ensure students develop professional skills meaningfully and effectively to enhance student-industry interactions.

ELECTRICAL AND ELECTRONICS ENGINEERING

Agastya Samshita available at Prince's Library of Ujjain in India, dates back to the first millennium BC, contains a detailed description construction of an electric battery/cell along with way to utilize the battery to 'split' water into its constituent gasses. The method of generating electricity using modern battery cell resembles Agastya's method. The materials used by Sage Agastya for generating electricity were an earthen pot, copper plate, copper sulphate, wet saw dust, zinc amalgam. As quoted in Agastya Samhita the open circuit voltage and short circuit current of the prepared cell are 1.138 volts and 23 mA respectively. He articulates 100 earthen pots on water, has the power to change the form of water to oxygen and hydrogen. If hydrogen is contained in an air tight cloth, it can be used in aerodynamics, i.e. it will fly in air. In an iron vessel and in a strong acidic medium, gold or silver nitrate covers copper with a layer of gold or silver. The copper that is covered by gold is called Shatakumbha or artificial gold.

Rao Saheb Krishnaji Vajhe, an engineer from Pune while reading books related to science found the pages of Agastya Samhita with Damodar Tryambak Joshi of Ujjain. Dr. M. C. Sahastrabuddhe, the Head of the Sanskrit Department in Nagpur, when reading Agastya Samhita found the similarity of it with of Daniel Cell. He requested P.P. Hole, the Professor of Engineering at Nagpur to investigate on the same.

On the basis of the descriptions in Agastya Samhita Mr. Hole and his friend started preparing the apparatus for the experiment. While preparing the set up they could not understand the meaning of shikhigreeva and while checking the Sanskrit dictionary, they understood that it meant the neck of a peacock. They went to Maharaja Park and asked the chief when a peacock would die. The chief was very angry and asked them to give in an application. After few days during a conversation with an Ayurveda expert he confirmed that shikhigreeva is copper sulphate, which solved their problem. Thus, a cell was formed and it had an open circuit voltage of 1.38 volts and short circuit current of 23 milli amperes. The results of the experimentation were communicated to Dr. M.C. Sahastryabuddhe. It was exhibited fourth general meeting at the Swadeshi Vigyan Sanshodhan Sanstha, Nagpur on August 7, 1990 to the scholars. It was concluded that the description was of an electric cell

On the basis on Agastya Samhita and other scriptures, Rao Saheb Vajhe, who spent his life in rummaging the Indian scientific scriptures, gave different names to electricity. The six ancient terminologies for electricity are:

- Tadit—produced by friction from leather or silk,
- Saudamini—produced by friction from gems or glass,
- Vidyut— from clouds or steam,
- Shatakoti alias Shatakumbhi—produced from a battery of hundreds of cells,
- Hradini—obtained from storage cells,
- Ashani—the one emanating from a magnetic rod.

MECHANICAL ENGINEERING

Mechanical engineering is one of the oldest disciplines of engineering, which requires the knowledge of mathematics, materials, physics and other engineering technologies. It is concerned with materials, processes and machines and requires the concepts of forces, moments, energy, entropy, work etc. The developments that are visible in all spheres of life have connection to mechanical engineering. Engineering has made a significant contribution in the development of civilizations and contribution of mechanical engineering in areas like construction of large scale structures including for irrigation, architecture, military etc. is significant. Difficult problems of the society have been solved using simple concepts of mechanical engineering, say for eg. use of lever principle to move heavy objects. In fact, mechanical engineering made a significant contribution to the first cycle of industrial revolution, i.e., industrial revolution 1.0 during the 18th century. James Watt is often called the 'Father of Mechanical Engineering', as his invention of steam engine led to significant developments during the industrial revolution and beyond. The earliest computers were mechanical devices with electronics.

Significant contributions have been made during the Vedic ages and the first ever mechanical device that was invented was wheel and potter. Surmyam Suiramiva identified metals like Fe, Cu, Ag, Au etc., during the Vedic times. People knew about materials and material processing during those times and identified terminologies for the same in Sanskrit and produced gold and silver coins.

Seers like Tritala, Jalayan, Karaa, Vayurathaa and Vidyutrathaa discovered about aerodynamics during Rig Veda period, much before Wright Brothers discovered about aero planes. Computational Fluid Dynamics (CFD) analysis, which we are talking about today for different analysis, was there in the Vimana Shastra slokas.

Mechanical and manufacturing technology of ancient India ensured processing of natural products and their transformation into goods of trade, commerce and export.

Many scientists have made significant contributions to this domain. Leonardo da Vinci (16th century) studied and designed many mechanical systems that were related to transportation and warfare. In 17th century, Isaac Newton contributed the Laws of Motion used in several applications. Rudolf Diesel (18th century) was a German inventor, who created the first successful diesel engine and today diesel engines play a very important role in the transport and power sector in the world. Carl Frederich Benz (18th century) was a German automotive engineer, who developed the first practical automobile.

Mechanical engineering has evolved over the years and today the advent of computer and IT tools has facilitated better mechanical engineering in terms of design, analysis, and manufacturing. A mechanical engineer needs to work in multiple domains and needs to possess multiple skills like design, redesign, analyze, test, manufacture etc. It has been one of the founding disciplines of engineering and has contributed and will keep contributing to the growth and developments in this physical world.

CIVIL ENGINEERING

Indian civilization was the oldest civilization in the world and has a strong tradition of science and technology. It was the land of sages, seers, scholars, and scientists. Hinduism is a knowledge-based civilization, the Vedic texts should not be ignored dismissed as mythologies or as the work of imagination or just containing some moral stories. The Veda means knowledge and they contain relevant knowledge otherwise these texts would not have survived the millennia years of the historic storm. Let us know some of the great work done in ancient times.

Ancient India not only practised scientific methods of design and construction but also documented them for future generations. Here are some tips given by ancient sages on selection of site and construction

(1) Vishwakarma Vastu Shastra- Vishwakarma explains the first point of construction in the ancient book Vastu Shastra – '□□□□□ □□□□□ □□□□□□□□□□□ □□□□□□□□ □□□□□□□ □□□□□□□□□□□□', This means that before construction one should test the land. Vishwakarma further says that construction should not be done on the land which is very mountainous or on land with large cracks.

Vastu shastra literally "science of architecture" are texts on the traditional Indian system of architecture. These texts describe principles of design, layout, measurements, ground preparation, space arrangement, and spatial geometry. The designs aim to integrate architecture with nature, the relative functions of various parts of the structure, and ancient beliefs utilising geometric patterns (yantra), symmetry, and directional alignments.

(2) Kashyap Shilpa (Craft) – In this ancient book, Kashyap Rishi has said that the foundation should be dug until water is seen because this way you would ensure that you have reached the rock level and the foundation would be strong.

(3) Bhrigu Samhita – In this scripture saint Bhrigu says that before buying land, one should test it for form, colour, juice, smell and touch. Rishi Bhrigu also explains its methods in his book.

Ancient cities of India found on the basis of archaeological discoveries:

- Rama was the world's first king to build a bridge across the sea. But he did not do it on his own. He sought the help of a great engineer called Nala according to Valmiki Ramayana. Any wise man will seek local knowledge when he ventures into new places. Nala knew the shallow areas across the sea in and around Tamilnadu. American space agency NASA also confirmed that there was a bridge through the satellite pictures. Any wise engineer will use such naturally elevated areas instead of deep waters to build a bridge.
- Bageeratha changed the course of the mighty river Ganges. The vast forest areas of modern Bihar, Uttar Pradesh, and West Bengal were made into fertile lands by his marvelous engineering feat. In those days very few people lived in those jungles. Puranas say that Bageeratha did penance for several thousand years to do this that too 'standing in one foot'. This is a phrase Indians use very often. Even the great Tamil poet Tiruvalluvar uses the simile of Stork that stands in one foot to catch a fish. This

is the hidden language to say that he tried for a very long time with focused attention.

- Vedic Saint Agasthya discovered the land route to South India via Vindhyas. The Puranas say that he “subdued the arrogance of the hills”, this is hidden language. Till Agastya’s this great discovery kings and travellers used only sea routes. Since they knew the secret of monsoon winds they can travel to West Bengal or Maharashtra from Sri Lanka in a few months’ time.
- Uparichara Vasu, an ancient king made mountain passes for the benefit of land travellers. He was a Vasu king ruling over the Chedi kingdom. Mahabharata says that he kicked the Kolahal Mountain which was blocking the flow of the Shaktimati River. This is a hidden language to say that he diverted the river for irrigation by cutting the hills.
- In short Bageerathan, Agastya, and Uparichara Vasu are the earliest engineers who built dams across the rivers. But unlike modern engineers, they did not use cement or mortar but they used the hills themselves. To avoid the force they made checks and balances. They use a hidden language saying that Shiva bore the force when Ganga came down from heaven.
- Parasuraman retrieved a lot of lands and gave it to Indians. A Pandya king called Nilam Tharu Vil Nediyon built sea walls to prevent the sea from invading the land.
- Balraman always travelled with an axe to clear the forests and make them cultivable. He was a great agriculturist. When Krishna spent most of his time in politics, his brother Balarama did constructive work.
- The Mohanjodaro, created 3000 years ago, is considered as a wonderful piece of civil engineering. Found in archaeological excavations even the ruins prove that this town was well settled and its buildings and roads – all were made using symmetry and geometrical measurements. The roads found in this city were straight and were made from east to west and north to south and surprisingly they were at an angle of 90 degrees from each other. Buildings were also constructed in proportion. The intersection of the corners, the heights of the walls was equal. The city had public buildings, gardens, a restaurant, a large public bath as well as residential buildings. There was a provision for bathroom, living room etc in the residential buildings. The public buildings were 11.82m long, 7.01m wide and 2.44m high, and there were two streams of water. The building material and bricks of the walls were coated with a substance on which there was no effect of water. Archaeological research shows that people living here were well-versed in the construction techniques.
- Indus Valley Cities such as Harappa, Mohanjadaro, Lothal, Dholavira, Kalibangan need no new interpretations. The well-laid cities with uniform brick structures, Great Bath, most hygienic drainage systems, grain storage barns, and wells are all already well known to the world.
- Dwarka, also known as Lord Krishna’s city, also narrates a similar story. Dr S R Rao discovered Dwarka in the archaeological excavation and found that the ancient city (Dwarka Nagar) was well built and settled. There was a wall around the city. The stones

used for the construction of buildings did not erode despite the fact that the city was very close to the sea. Two-storey buildings, roads and water system are also found in the city. Copper, bronze and some alloys with zinc mixed up to 34 percent have also been found during the excavation. The size of columns, windows, etc reveals that they were designed with a complete mathematical precision.

- South Indian Tamil saint Appar always travelled with a pickaxe to clear the bushes from the temple towers. He simply followed Balarama. Great Chola king Karikalan built a dam across river Cauvery in Kal Anai. The Grand Anicut was an engineering wonder of ancient Tamils. It was built around the 1st century AD. Big temples of India, the number of which runs into thousands, stand as monumental proof for the engineering skills of Indians. Mamallapuram and other Pallavacave temples are well-known milestones in Indian architecture.
- The Group of Monuments at Hampi are also recognized as a UNESCO World Heritage Site. The Vittala temple—the stone chariot – is the most iconic symbol of Hampi. The Virupaksha Temple at Hampi was built in the seventh century by the Chalukya rulers.

Virupaksha and Vithala Temple in Hampi

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Scheme & Syllabus for
B. Tech. (Electrical and Electronics Engineering)

HIGHER SEMESTER COURSES

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
2023-24

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

2nd Year Scheme

III Semester

Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Lecture L	Tutorial T	Practical/ Drawing P	Self Study/PBL J	Duration in hours	CIE Marks	SEE Marks	Total	
1	BSC	MA2004-1	Vector Calculus & Transform Techniques	MA	3	0	0	0	03	50	50	100	3
2	IPCC	EE2003-1	Microcontroller	EE	3	0	2	0	03	50	50	100	4
3	IPCC	EE2005-1	Network Analysis	EE	3	0	2	0	03	50	50	100	4
4	PCC	EE2101-1	Analog Signal Processing	EE	3	0	0	0	03	50	50	100	3
5	PCC	EE2104-1	Generation Transmission & Distribution	EE	3	0	0	√	03	50	50	100	3
6	PCC	EE2601-1	Analog Signal Processing Laboratory	EE	0	0	2	0	03	50	50	100	1
7	HSMC	HU1004-1	Universal Human Values	Any Dept.	1	0	0	0	01	50	50	100	1
8	AEC	ME1654-1	Innovations and Design Thinking	ME	1	0	0	0	01	50	50	100	1
9	MNC	HU1003-1	Kannada (Balake / Samskrithika)	Any Dept.	1	0	0	0	-	50	-	50	0
				Total	**18**	**0**	**6**	**-**	**20**	**450**	**400**	**850**	**20**
Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
10	MNC	MA1011-1	Bridge Course- Calculus & Laplace Transforms	MA	3	0	0	0	3	100	0	100	0

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

2nd Year Scheme

IV Semester

Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Lecture L	Tutorial T	Practical/ Drawing P	Self Study/PBL J	Duration in hours	CIE Marks	SEE Marks	Total	
1	BSC	MA2008-1	Probability Theory and Numerical Methods	MA	3	0	0	0	03	50	50	100	3
2	IPCC	EE2002-1	Instrumentation and Measurements	EE	3	0	2	0	03	50	50	100	4
3	IPCC	EE3002-1	Linear Control Systems	EE	3	0	2	0	03	50	50	100	4
4	PCC	EE2102-1	Electrical Machines-I	EE	3	0	0	0	03	50	50	100	3
5	PCC	EE2103-1	Electromagnetic Fields	EE	3	0	0	√	03	50	50	100	3
6	PCC	EE2602-1	Electrical Machines-I Laboratory	EE	0	0	2	0	03	50	50	100	1
7	HSMC	HU2001-1	Enhancing Self Competence	HU	2	0	0	0	03	50	50	100	2
8	VEC	EEx5xx-1 (EE2551-1)	Department specific Vocational Education Course (Soldering Practice)	EE	0	0	2	0	03	50	50	100	1
9	HEC	HU1005-1	Essence of Indian Culture	HU	1	0	0	0	-	50	-	50	0
10	INT	UC1001-1	Internship – I (Activity Based Internship)	Mandatory Intra Institutional Activity based Internship of 2 weeks duration (80 - 90 h) to be completed during the vacations of I & II Semesters. Lateral entry students have to complete the Internship - I during the vacation of III semester					-	100	-	100	2
				Total	**18**	**0**	**8**	**-**	**24**	**550**	**400**	**950**	**23**
Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
10	MNC	MA1013-1	Bridge Course- Probability & Differential Equations	MA	3	0	0	0	3	100	0	100	0

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

3rd Year Scheme

V Semester

Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week: Lecture L	Tutorial T	Practical/ Drawing P	Self Study/PBL J	Examination: Duration in hours	CIE Marks	SEE Marks	Total	Credits
1	IPCC	EE2001-1	Electrical Machines-II	EE	3	0	2	0	3	50	50	100	4
2	IPCC	EE2004-1	Modern Switchgear and Protection	EE	3	0	2	0	3	50	50	100	4
3	PCC	EE3101-1	Power Electronics	EE	3	0	0	0	3	50	50	100	3
4	PCC (Lab)	EE3602-1	Power Electronics Laboratory	EE	0	0	2	0	3	50	50	100	1
5	PEC	EExxxx-1	Professional Elective-I (Group I)	EE	3	0	0	0	3	50	50	100	3
6	HSMC	HU1006-1	Introduction to IPR	Any Dept.	1	0	0	0	1	50	50	100	1
7	AEC	HU1010-1	Research Methodology	Any Dept.	2	0	0	0	3	50	50	100	2
		XXx6xx-1	Program Specific Ability Enhancement Course	EE	1	0	2	0					
8	AEC	HU1007-1	Social Connect & Responsibility	Any Dept.	1	0	0	0	1	50	50	100	1
9	AEC	UM1003-1	Employability Skill Development	EE	1	0	0	0	-	50	0	50	1
				Total	**17/16**	**0**	**8**	**-**	**20**	**450**	**400**	**850**	**20**

VI Semester

Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week: Lecture L	Tutorial T	Practical/ Drawing P	Self Study/PBL J	Examination: Duration in hours	CIE Marks	SEE Marks	Total	Credits
1	IPCC	EE3003-1	Signal Analysis and Processing	EE	3	0	2	0	3	50	50	100	4
2	PCC	EE3102-1	Power System Analysis and Stability	EE	3	0	0	0	3	50	50	100	3
3	PCC (Lab)	EE3603-1	Power System Analysis and Stability Laboratory	EE	0	0	2	0	3	50	50	100	1
4	PEC	EEx2xx-1	Professional Elective – II (Group -I)	EE	3	0	0	0	3	50	50	100	3
5	PEC	EEx3xx-1	Professional Elective -III (Group-II)	EE	3	0	0	0	3	50	50	100	3
6	OEC	XXX5XX-1	Open Elective –I	Any Dept.	3	0	0	0	3	50	50	100	3
7	HSMC	MG1003-1	Management & Entrepreneurship	Any Dept.	3	0	0	0	3	50	50	100	3
8	AEC	HU1008-1	Life Skills for Engineers	HU	1	0	0	0	1	50	50	100	1
				Total	**19**	**0**	**4**	**-**	**22**	**400**	**400**	**800**	**21**

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

4th Year Scheme

VII Semester														
Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Examination					Credits
					Lecture L	Tutorial T	Practical/ Drawing P	Self Study/PBL J	Duration in hours	CIE Marks	SEE Marks	Total		
1	IPCC	EE3001-1	Industrial Drives and Applications	EE	3	0	2	0	3	50	50	100		4
2	PCC (Lab)	EE3601-1	High Voltage Engineering Laboratory	EE	0	1	1	0	3	50	50	100		1
3	PEC	EEx2xx-1	Professional Elective – IV (Group-I)	EE	3	0	0	0	3	50	50	100		3
4	PEC	EEx3xx-1	Professional Elective – V (Group-II)	EE	3	0	0	0	3	50	50	100		3
5	OEC	XXX5XX-1	Open Elective –II	Any Dept.	3	0	0	0	3	50	50	100		3
6	HSMC	MG1002-1	Financial Management	Any Dept.	3	0	0	0	3	50	50	100		3
7	HEC	HU1009-1	Indian Knowledge Systems	HU	1	0	0	0	-	50	0	50		1
8	UCC	UC3001-1	Major Project Phase I	EE	-	-	4	-	-	100	0	100		2
				Total	**16**	**1**	**7**	**-**	**18**	**450**	**300**	**750**		**20**

VIII Semester													
Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Lecture L	Tutorial T	Practical/ Drawing P	Self Study/PBL J	Duration in hours	CIE Marks	SEE Marks	Total	
1	UCC	UC2001-1	Internship- II (Societal internship and Research/Industry Internship)		Mandatory Societal internship for 2 weeks (80 – 90 h) and Research Internship / Industry Internship of 6 weeks (240 – 270 h) or Research Internship / Industry Internship for a total of 8 weeks (320 – 360 h)to be completed in one/two stretches during the vacation periods between IV to VII semesters				3	50	50	100	8
2	UCC	UC3002-1	Major Project Phase II		Student should carry out project in research institute/industry/intra institute Center of Excellences. Two contact hours /week for interaction between the project guide and students.				3	100	100	200	8
				Total	**-**	**-**	**-**	**-**	**6**	**150**	**150**	**300**	**16**

B.Tech. (EE): Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

Program Specific Ability Enhancement Courses [AEC]	
Course Code	**Course Title**
HU1010-1	Research Methodology
EE3651-1	ECAD (1-0-2)
EE2651-1	Hardware System Design (1-0-2)
EE2652-1	Internet of Things (1-0-2)
EE2653-1	Python Programming for Electrical Engineering (1-0-2)

Vocational Education Courses [VEC]	
Course Code	**Course Title**
EE2551-1	Soldering Practice
EE2551-2	Troubleshooting Electrical Appliances

List of Professional Elective Courses [PEC]			
Group-1		**Group-2**	
Power Electronics & Drives Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2201-1	Power Semiconductor Devices	EE3301-1	Power Electronics System Design using ICs
EE3201-1	Switched Mode Power Converters	EE3302-1	Solid State Lighting Control
EE4201-1	Computer Control of Electrical drives	EE3303-1	Special Electrical Machines
		EE3304-1	Electrical Machine Design
Control System Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2211-1	Robotics and Automation	EE2311-1	Programmable Logic Controllers
EE3211-1	Physiology Control System Modelling and Simulation	EE2312-1	Micro- and Nano-Scale Sensors and Transducers
EE4211-1	Advanced Control System	EE3311-1	Advanced Instrumentation Systems
EE4212-1	Discrete Control Systems	EE3312-1	Industrial Servo Control Systems
Energy System Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2221-1	Demand Side Management	EE2321-1	Illumination Technology
EE2222-1	Renewable Energy Sources	EE2322-1	Operation and Maintenance of Solar Electrical Systems
EE2223-1	Electrical Circuits and Power Distribution	EE3321-1	Electrical Power Utilization
EE4221-1	Electrical Power Quality	EE3322-1	Industrial Heating
EE4222-1	Integration of Distributed Generation Systems		
Power System Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2231-1	Electrical Estimation and Costing	EE3331-1	High Voltage Engineering
EE3231-1	Power System Planning	EE4331-1	Power System Dynamics and Stability
EE3232-1	Smart Electric Grid	EE4332-1	Reactive Power Management
EE3233-1	FACTS & HVDC	EE4333-1	Power System Operation & Control
EE3234-1	Computer Techniques in Power Systems		

Microelectronics Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE3241-1	ARM System Architecture	EE3341-1	Digital Systems Design using Verilog HDL
EE3242-1	VLSI Circuits & Design	EE3342-1	Embedded Systems
EE4241-1	VLSI Layout Techniques	EE3343-1	Introduction to ASIC and FPGA
EE4242-1	High Speed Digital Design	EE3344-1	Linear Integrated Circuits and its Applications
Electric Vehicle Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2251-1	Automotive Electronics	EE2351-1	Automotive Security
EE2252-1	Hybrid Electric Vehicles	EE2352-1	Battery storage and Fuel Cells for Electric Vehicles
EE3251-1	Energy storage & Battery management systems	EE3351-1	Electric Vehicle Battery Charging Techniques
EE3252-1	Power Electronics & Drives for Electric Vehicles	EE3352-1	Modeling and Control of Hybrid Electric Vehicles
EE3253-1	Thermal Management of EV systems	EE3353-1	Vehicle management control
Information Technology Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2261-1	Database Management System	EE2361-1	Operating Systems Fundamentals
EE2262-1	Object Oriented Programming using C++	EE3361-1	Introduction to Machine Learning with Python
EE2263-1	MATLAB Programming for Engineers	EE3362-1	Probability and Information Theory
EE3261-1	Computational Linear Algebra		
Artificial Intelligence and Data Science			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
EE2271-1	Data Science Engineering	EE2371-1	Fuzzy Logic Control
EE2272-1	Introduction to Artificial Intelligence	EE2372-1	Introduction to Big data Analytics
EE2273-1	Introduction to Artificial Neural Networks	EE3371-1	Image Processing
EE4271-1	AI Applications to Power Systems	EE3372-1	Matrix Methods in Machine Learning

Courses from Basic Science

VECTOR CALCULUS & TRANSFORM TECHNIQUES

Course Code:	**MA2004-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**MA1001-2**		

Teaching Department: Mathematics

Course Objectives:

1.	Apply operators like gradient, divergence and curl to both scalar as well as vector functions.
2.	Evaluate surface and volume integrals in terms of line integrals using various integral theorems.
3.	Identify the functions in engineering problems as analytic function and their study as a function of a complex variables.
4.	Study Cauchy's theorem and formulae, and specify some difficult integration that appear in applications can be solved by complex integration.
5.	Perform Fourier analysis on non-sinusoidal periodic signals and apply Z-transform technique to solve difference equations.

UNIT-I

Vector Calculus — **15 Hours**

Vector algebra (review), vector differentiation-gradient, directional derivatives, divergence, curl, Laplacian, solenoidal and irrotational vectors. Curvilinear, spherical and cylindrical co-ordinates.
Vector integration: Line, surface & volume integrals. Green's, Gauss divergence & Stoke's theorems and applications.

UNIT-II

Theory of Complex Variables — **15 Hours**

Functions of complex variables, Cauchy Riemann equations, properties of analytic functions, conformal mapping, bilinear transformations.
Line integrals in complex plane, Cauchy's theorem, Cauchy's integral formula. Power series, Taylor's and Laurent's series. Residues, Cauchy's residue theorem. Evaluation of standard real integrals using contour integration.

UNIT-III

Fourier Series & Z-Transforms — **10 Hours**

Periodic functions, Euler's formulae, Trigonometric Fourier series.
Z transforms: Z-transforms of standard functions, Bilateral Z- Transform. ROC, linearity, Time shift, Convolution, Scaling & Differentiation in Z-Domain, Time reversal property, Initial and Final Value Theorems.
Inverse Z-transform: Partial Fraction Method, Power series/ division method, Contour integral Method.
Unilateral Z-Transform: Properties, Solution of difference equations.

Course Outcomes: At the end of the course student will be able to

1.	Solve the vector functions and their derivatives for engineering applications.
2.	Demonstrate the applications of Gauss divergence and Stoke's theorem.
3.	Solve Engineering problems using complex variable techniques.
4.	Illustrate the concept of complex variables and line integrals in complex plane.
5.	Apply the analytical technique to express periodic function as a Fourier sine and cosine Series and apply the concepts of Z- transforms to solve engineering problems.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA2004-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2004-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2004-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2004-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2004-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B. S. Grewal, "Higher Engineering Mathematics", 43rd edition.
2.	Kreysizg, "Advanced Engineering Mathematics", John Wiley and Sons, 6th Edition.

REFERENCE BOOKS:

1.	Wylie Ray, "Advanced Engineering Mathematics", 6th edition, McGraw Hill.Inc.
2.	Murray R. Spiegal, "Vector Analysis", Schuam Publishing Co.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/111106100
2.	http://nptel.ac.in/courses/111106139
3.	http://nptel.ac.in/courses/111107111

PROBABILITY THEORY AND NUMERICAL METHODS

Course Code:	**MA2008-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisites	**MA1001-1**		

Teaching Department: Mathematics

Course Objectives:

1.	Understand the concept of probabilistic models for situation involving chance effect.
2.	Study different types of probability distributions.
3.	Apply interpolation technique in real life problems
4.	Apply numerical differentiation and integration methods, where the function is a
5.	Complicated expression or given in terms of tabular values or not possible to evaluate

UNIT-I

Probability Theory — **15 Hours**

Finite sample space, probability and conditional probability and independence, Bayes' theorem. One dimensional random variable: discrete and continuous random variable, probability functions, cumulative distribution function, expectation and variance. Two Distributions: Binomial, Poisson, Normal and exponential distributions

UNIT-II

Finite Differences and Interpolation — **15 Hours**

Finite differences: forward, backward and central difference operators, Newton-Gregory forward and backward interpolation formulae, Lagrange's interpolation formula, Lagrange's Inverse interpolation formula. Newton's divided difference interpolation formula.

Numerical Differentiation: Numerical differentiation using Newton's forward & backward formulae.

Numerical integration: General quadrature formula, Trapezoidal rule, Simpson's one third rule, Simpson's three eighth rule.

UNIT-III

Numerical Methods — **10 Hours**

Solution of algebraic and transcendental equations: Regula falsi Method and Newton Raphson Method.

Numerical solution of ordinary differential equations: Taylor's series method, modified Euler's method and 4th order Runge –Kutta method, Predictor-Corrector methods

Numerical solution of partial differential equations: Solution of Laplace and Poisson equations by standard five point formulae, solution of heat and wave equations.

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate and appreciate probabilistic models for situations involving chance effect.
2.	Illustrate the applications different types of distributions for engineering problems.

3.	Using finite differences and interpolation technique in solving real life problems
4.	Understand the numerical differentiation and integration methods and be able to apply these methods to solve engineering problems
5.	Apply numerical methods to solve partial differential equations.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA2008-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2008-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2008-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2008-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2008-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. B. S. Grewal, “Higher Engineering Mathematics”, 43rd Edition, Khanna publishers, 2012.

2. P. L. Meyer, “Introduction of probability and Statistical applications”, Second Edition, American Publishing Co., 1975.

REFERENCE BOOKS:

1. Kreysizg, “Advanced Engineering Mathematics”, John Wiley and Sons, 6th Edition.

2. S. S. Sastry, “Introductory methods of Numerical Analysis”, 2nd Edition, Prentice Hall, 1990.

3. Wylie Ray, “Advanced Engineering Mathematics”, 6th Edition, McGraw Hill.Inc

Bridge Courses for Lateral Entry Students

BRIDGE COURSE - CALCULUS & LAPLACE TRANSFORMS (COMMON TO CV\EC\EE\ME)

Course Code:	**MA1011-1**	**Course Type:**	**MNC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**00**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**100+00**

Teaching Department: Mathematics

Mandatory Non – credit course (MNC):

This course is prescribed to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, they shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.

MNC Courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree

Course Objectives:

This course will enable the students to master the basic tools of differential calculus, partial differentiation, Laplace Transforms and Integration and become skilled for solving problems in science and engineering.

UNIT-I

DIFFERENTIAL CALCULUS	**07 Hours**

Limit, continuity, differentiation rules-product rule, quotient rule and chain rule. Taylor's series, Maclaurin's series of simple functions in single variable.

PARTIAL DIFFERENTIATION	**08 Hours**

Definition, simple problems to find partial differentials, total differentiation, differentiation of composite functions, illustrative examples and problems. Taylor's and Maclaurin's series for a function of 2 variables.

UNIT-II

LAPLACE TRANSFORMS	**07 Hours**

Definitions, transforms of elementary functions, transforms of derivatives and integrals-properties.

INVERSE LAPLACE TRANSFORM	**08 Hours**

Inverse Laplace transforms and properties. Solutions of ordinary differential equations. Applications to engineering problems.

UNIT-III

INTEGRAL CALCULUS-I	**5 Hours**

Introduction, rules of integration, solution of integrals using the methods-substitution and partial fraction, integrals of standard functions, definite integral, simple problems.

INTEGRAL CALCULUS-II	**5 Hours**

Double integrals, change of order of integration, change in to polar coordinates. Triple integrals, simple Problems and applications.

Course Outcomes: At the end of the course student will be able to

1.	Learn the concept of limit, continuity, differentiability and Taylor's theorem.
2.	Learn the concept of partial differentiation of a function with two or more independent variables.
3.	Apply the concept of Laplace transform in engineering applications.
4.	Find the inverse Laplace transform and hence to solve differential equations
5.	Apply the notion of multiple integrals to find areas and volumes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA1011-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1011-1.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1011-1.3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MA1011-1.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1011-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.

REFERENCE BOOKS:

1.	G. B. Thomas and R. L. Finney, "Calculus and Analytic Geometry", Pearson, 2002.
2.	T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
3.	B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi, 2010.

BRIDGE COURSE - PROBABILITY & DIFFERENTIAL EQUATIONS (COMMON TO CV\EC\EE\ME)

Course Code:	**MA1013-1**	**Course Type:**	**MNC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**00**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**100+00**

Teaching Department: Mathematics

Mandatory Non – credit course (MNC):
This course is prescribed to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, they shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.

Course Objectives:
This course will enable the students to master the basic tools of matrix theory, probability, differential equations, partial differential equations and become skilled for solving problems in science and engineering.

UNIT-I

MATRICES — **08 Hours**

Elementary operations of a matrix, echelon form of a matrix, Rank of a matrix (both definitions). Consistency and solution of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of matrices.

PROBABILITTY — **07 Hours**

Finite sample space, event, mutually exclusive event, equally likely event, probability, addition theorem, conditional probability and independence conditions, multiplication theorem. Bayes' theorem.

UNIT-II

DIFFERENTIAL EQUATIONS — **08 Hours**

Introduction, order and degree of differential equations, examples. Solution of first order and first-degree differential equations–variable separable method, Linear, Bernoulli’s and exact differential equations (without I. F).

SECOND AND HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS — **07 Hours**

Second order linear differential equation with constant coefficients, solution by inverse differential operator and method of variation of parameters.

UNIT-III

FIRST AND HIGHER ORDER PARTIAL DIFFERENTIAL EQUATIONS — **10 Hours**

First and higher order partial differential equations. Formation of partial differential equations by elimination of arbitrary constants/ arbitrary functions. Solution of PDE's by direct integration method.

Course Outcomes: At the end of the course student will be able to

1.	Reduce the matrix to echelon form and find its rank
2.	Understand the concept of probability and apply Bayes theorem to real life problems
3.	Solve the differential equations
4.	Solve higher order linear differential equations
5.	Form partial differential equations by eliminating the arbitrary constants and functions

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA1013-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1013-1.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1013-1.3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1013-1.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1013-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.
3.	P. L. Meyer, "Introduction of Probability and Statistical Applications", 2nd Edition, American Publishing, 1975.

REFERENCE BOOKS:

1.	T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
2.	B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.
3.	N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.

Integrated Professional Core Courses

ELECTRICAL MACHINES-II

Course Code:	**EE2001-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE1001-2**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the working principle and operating characteristics of DC machine
2.	To understand testing methods of DC Machine and to get introduced to special machines.
3.	To study the working principle and operating characteristics of synchronous machine .
4.	To get acquainted with methods to predetermine voltage regulation of synchronous generator.
5.	To understand the process of synchronization of alternator to infinite bus.
6.	To get familiarized with the working principle, characteristics, testing and applications of Synchronous motor.

UNIT-I

DC motors	**08 Hours**

Review of operating principle, Armature reaction, commutation, use of inter poles & pole face compensating winding Characteristics, Speed control of shunt & series motors, losses & efficiency, condition for maximum efficiency.
DC Motor Starter: necessity, 3 -point, 4-point starter

Testing of DC motors	**02 Hours**

Swinburne's test, Hopkinson's test , Retardation test, Field's test on series motor

Special Motors:	**05 Hours**

Principle of operation of Brushless DC motor, Stepper motor and Permanent magnet DC motors.

UNIT-II

Synchronous machines	**09 Hours**

Review of principle of operation, construction of salient & non Salient pole synchronous machines. Generated EMF in a concentrated winding, effect of distribution of winding & use of chorded coils, Regulation by EMF, MMF, ZPF Methods

Parallel operation of alternators	**06 Hours**

Parallel operation of alternators, Synchronizing of Alternators to infinite bus bars, operating characteristics, power angle characteristics, operation at constant load with variable excitation for generating mode

UNIT-III

Salient pole synchronous machines	**05 Hours**

Salient pole synchronous machines, two reaction theory, power angle diagram, reluctance power, slip test.

Synchronous motors	**05 Hours**

Principle of operation, starting methods. Motor at constant load variable excitation. V and inverted V curves, hunting in synchronous machines, synchronous condenser and applications.

Suggested List of Experiments

1.	Load test on DC Motor-Determination of speed torque and BHP efficiency characteristics
2.	Speed control of DC motors by Armature Voltage and Flux control methods.
3.	Swinburne's Test
4.	Hopkinson's Test
5.	Field test on series motors
6.	Load test on BLDC motor
7.	Voltage Regulation of Alternator by EMF and MMF method
8.	Voltage regulation of alternator by ZPF method
9.	Slip test
10.	V and inverted V curves of a synchronous motor.

Course Outcomes: At the end of the course student will be able to

1.	Describe the effect of the armature reaction to justify the use of inter-poles and compensating winding and comprehend speed control of a DC motor.
2.	Analyze the characteristics, starters and testing methods to select and evaluate the performance parameters of different DC motors and have a broad idea about special machines such as Brushless DC motor.
3.	Outline the constructional features of alternators and describe tests to predetermine the voltage regulation.
4.	Describe the process of synchronization of alternators and analyze its performance characteristics.
5.	Analyze the performance of salient pole synchronous machine, starting methods and applications of synchronous motor.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2001-1.1	3	3	-	-	-	-	-	-	2	2	-	1	-	1
EE2001-1.2	3	3	-	-	-	-	-	-	2	2	-	1	-	1
EE2001-1.3	3	3	-	-	-	-	-	-	2	2	-	1	-	1
EE2001-1.4	3	3	-	-	-	-	-	-	2	2	-	1	-	1
EE2001-1.5	3	3	-	-	-	-	-	-	2	2	-	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. P. S. Bhimbra, "Electric machinery", Khanna publishers , 7th Edition, 2011.
2. Ashfaq Hussain, "Electrical Machines", Dhanpat Rai Publications, 2012.Electrical Engineering Fundamentals, Vincent Del Toro, 2nd Edition, Pearson, 2015.

REFERENCE BOOKS:

1. AE Clayton & Hancock, "Performance & design of DC machine", ELBS Publication, 1^{st} edition,2004.
2. Alexander Langsdorf, "Theory of alternating current machines", TMH, 2nd Edition , 2004.
3. J.B. Gupta, "AC and DC Machines", S K Kataria and Sons publications, 2012 edition.

E Books / MOOCs/ NPTEL

1. NPTEL Course on Electrical Machines - I, Prof. Tapas Kumar Bhattacharya, IIT Kharagpur.
2. NPTEL Course on Electrical Machines - II, Prof. Tapas Kumar Bhattacharya, IIT Kharagpur.
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/course-notes/

INSTRUMENTATION AND MEASUREMENTS

Course Code:	**EE2002-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To measure the resistance, inductance and capacitance by using different bridges
2.	To study the construction and working of various meters used for measurement of electrical quantities
3.	To introduce various sensors and transducers, study their working and applications
4.	To introduce various electronic instruments & display devices and learn their applications

UNIT-I

Instruments	**03 Hours**
Introduction, Characteristic of instruments, errors	
Measurement of R, L, and C	**07 Hours**
Measurement of Resistance, Inductance, and Capacitance: Wheatstone's bridge, KDB, Measurement of High resistance, Maxwell's bridge, Schering bridge, Anderson's Bridge Shielding of bridges, Murray Loop Test, Measurement of earth resistance by fall of potential method, LCR Meters	
Extension of Instrument Ranges	**03 Hours**
Principles of Shunts and multipliers used to extend instrument range, examples.	
Energy Meter	**02 Hours**
Errors, adjustments and calibration of Induction type energy meter. Introduction to Digital Energy Meter	

UNIT-II

Sensors	**02 Hours**
Roll of sensors in engineering, classification of transducers	
Frequency and Phase	**02 Hours**
Principle of measurement of frequency and phase angle, Weston frequency meter, power factor meter and phase sequence indicator.	
Linear Displacement	**05 Hours**
Resistive Potentiometers, strain gauge, LVDT, Capacitive Piezoelectric, Hall Effect sensors, Optical displacement sensor, fiber optic sensor, Ultrasonic distance Sensor, Linear encoder	
Rotational Displacement	**02 Hours**
Optical tachometer, Rotary encoder, gyroscope	
Temperature measurement	**02 Hours**
Classification of temperature sensors Resistance Temperature Detectors, Thermistor	
Recorder	**02 Hours**
Magnetic recording, digital recording, optical recording	

UNIT-III

Display devices	**05 Hours**
7 segment display, dot matrix displays, LCD and LED display. Photo conductive, photo-voltaic cells.	
Electronic Instruments	**05 Hours**
Introduction, True RMS responding voltmeter, Electronic multimeters, ADC (Flash, SAR), DAC, Digital	

voltmeters, block diagram of a digital storage oscilloscope, Method of measuring amplitude, period, phase, frequency, Use of Lissajous patterns, broken ring and modulated ring method, Sampling Oscilloscope

Suggested List of Experiments

1.	Measurement of low resistance using Kelvin Double Bridge
2.	Measurement of Capacitance using Schering Bridge
3.	To study the construction and working principle of PMMC and moving iron instrument.
4.	Adjustment & calibration of 1-phase energy meter
5.	To study characteristics of temperature transducer like thermocouple, thermistor and RTD with signal conditioning circuits like instrumentation amplifier.
6.	Measurement of strain using strain gauge
7.	Study of distance measurement using ultrasonic transducer
8.	To study differential pressure transducer & signal conditioning of output signal
9.	To study blockwise construction of a multimeter & frequency counter

Course Outcomes: At the end of the course student will be able to

1.	Apply a suitable measurement technique to determine the value of unknown resistance/capaci inductance
2.	Describe the extension of instrument range to measure the large voltages & currents and calib energy meter
3.	Describe the principle of different sensors for the measurement of frequency, and linear displac
4.	Describe the principle of different sensors for the measurement of rotational displacement, temperature and recording the measured quantities using recorders
5.	Illustrate the working of display devices and different electronic instruments to measure analog signals

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2002-1.1	3	3	-	-	-	-	-	-	2	2	-	1	1	-
EE2002-1.2	3	3	-	-	-	-	-	-	2	2	-	1	1	-
EE2002-1.3	3	3	-	-	-	-	-	-	2	2	-	1	1	-
EE2002-1.4	3	3	-	-	-	-	-	-		-	-	1	-	-
EE2002-1.5	3	3	-	-	-	-	-	-	2	2	-	1	1	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. A. K. Sawhney, "Electrical and Electronic Measurements and Instrumentation",Dhanpatrai and Sons, New Delhi, 2004.

2. David A. Bell, "Electronic Instrumentation and Measurement", 2nd Edition, P.H.I, 2006.

3. H.S. Kalsi, "Electronic Instrumentation"-second edition, Tata McGraw hill publications, 2004

REFERENCE BOOKS:

1. Cooper D. and A.D. Heifrick, "Modern Electronic Instrumentation and Measuring Techniques", P.H.I

2.	Golding and Widdies, "Electrical Measurements and Measuring Instruments", Pitman
E Books / MOOCs/ NPTEL	
1.	http://nptel.ac.in/courses/108105064/

MICROCONTROLLER

Course Code:	**EE2003-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1004-1, EC1002-2**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand architectural features of microcontroller and addressing modes of 8051
2.	To know working of interrupts, timers and serial communication principles
3.	To understand interfacing concepts
4.	To perform case studies on applications of microcontrollers

UNIT-I

8051 Architecture	**03 Hours**
Introduction, Features of SST89x516RD2, Architecture and pin diagram of SST89x516RD2, Memory organization, Stacks, I/O port structure and configuration.	
Addressing Modes	**04 Hours**
Introduction, Instruction syntax, Instruction timing, Data types in C, Addressing modes, embedded C instructions for data manipulations, C program.	
8051 Interrupts and Timers/counters	**08 Hours**
Timers and Counters, 8051 timers/counters, programming 8051 timers in C, Basics of interrupts, 8051 interrupt structure.	

UNIT-II

8051 Serial Communication	**03 Hours**
Data communication, Basics of Serial Data Communication, 8051 Serial Communication, connections to RS-232 (DB-9 only), Serial communication Programming in C.	
8051 Interfacing and Applications	**12 Hours**
Interfacing 8051 to LED, buzzer, switch, seven segment display, Keyboard, LCD, relay, parallel and serial ADC, DAC, Stepper motor interfacing, DC motor interfacing and PWM, External memory interfacing.	

UNIT-III

Case Studies	**10 Hours**
Home Automation System, Security System, Temperature monitoring and Control, Speed Measurement and Control, Automatic Irrigation System, Measurement of Voltage and Current.	
man	

Suggested List of Experiments

1.	Demonstration of various addressing modes
2.	Applications of logical and arithmetic instructions
3.	Applications of branch and loop instructions
4.	Embedded C programing to interface LEDs and Buzzer
5.	Embedded C programing to interface Switch and Seven Segment Display
6.	Embedded C programing to interface Hex Keypad with Seven Segment Display
7.	Embedded C programing to interface LCD
8.	Embedded C programing to interface ADC
9.	Application of serial communication for debugging and interfacing of relay

10.	Embedded C programing to interface DAC
Demonstration Experiments	
1.	Demonstration of interfacing of DC motor
2.	Demonstration of interfacing of Stepper motor

Course Outcomes: At the end of the course student will be able to

1.	Illustrate the basics of microcontrollers and outline the architecture, pin diagram, memory organization, different addressing modes of 8051 microcontroller
2.	Apply the concepts of interrupts, timer/counter to develop a program for given application
3.	Apply the concepts of serial communication to develop a program for given application
4.	Apply the programming skills to interface external hardware units with 8051
5.	Design real world applications using 8051

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2003-1.1	3	2	2	-	3	-	-	-	2	2	1	1	1	2
EE2003-1.2	3	3	3	-	3	-	-	-	2	2	2	1	2	2
EE2003-1.3	2	2	3	-	2	-	-	-	2	2	1	1	2	2
EE2003-1.4	3	3	3	-	3	-	-	-	3	3	2	2	2	2
EE2003-1.5	3	3	3	-	3	-	-	-	3	3	2	2	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kenneth J. Ayala, "The 8051 Microcontroller Architecture, Programming & Applications", 2e, Penram International, 1996 / Thomson Learning 2005.
2.	Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; "The 8051 Microcontroller and Embedded Systems – using assembly and C" -, PHI, 2006 / Pearson, 2006
3.	V.Udayashankar and Malikarjuna Swamy, "The 8051 Microcontroller", TMH, 2009

REFERENCE BOOKS:

1.	Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2005
2.	Micro-LABlet Hardware and Software Design Documents, Version_0D, Department of E&E, NMAMIT, Nitte, 2016
3.	Datasheet, "SST89E516RD2-Flashflex MCU", Microchip Technology

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108105102
2.	https://www.coursera.org/specializations/iot

MODERN SWITCHGEAR AND PROTECTION

Course Code:	**EE2004-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE2104-1, EE2102-1, EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the basic equipment in power system/substation.
2.	To familiarize with the different grounding systems implemented in power systems.
3.	To understand the construction and working of different types of circuit breakers used in power systems.
4.	To study the characteristics and working of various types of relays
5.	To understand the various protection schemes of electrical machines.

UNIT-I

Switches, fuses and Circuit breakers :	**06Hours**

Isolating switch, load breaking switch, Fuse law, cut-off characteristics, Time current characteristics, fuse material, HRC fuse, liquid fuse, Application of fuse.
Principles of AC Circuit breaking, Principles of DC Circuit breaking, problems encountered in DC breaking, Initiation of arc, maintenance of arc, Theory of arcing and arc quenching circuit breakers-types – rating and comparison, RRRV, Resistor switching and capacitor switching.

Static Relays	**04Hours**

Basic Block diagram, Advantages of Static Relays, Comparators, Phase and amplitude Comparators, General Equations of Comparators, Analysis of Amplitude and Phase Comparators, Operating principles, Static Overcurrent relays, Differential relays, and distance relays.

Basic Elements of Digital Protection:	**05 Hours**

Relays – General classification, Principle of operation, types, characteristics, Torque equation, Relaying Schemes, Relay Co-ordination.
Basic Components of a Digital Relay, Signal Conditioning Subsystems, Transducers, Surge Protection Circuits, Analogue Filtering, Analogue Multiplexers, Conversion Subsystem, The Sampling Theorem, Signal Aliasing Error, Sample and Hold Circuit, Digital Multiplexing ,Digital-to-Analogue Conversion, Analogue-to-Digital Conversion, Digital Relay Subsystem, Benefits of digital relays.

UNIT-II

Load-Shedding and Frequency Relaying:	**08 Hours**

Introduction, Rate and Frequency Decline, Load-Shedding, Frequency Relays, Induction-Cylinder under frequency Relays, Digital Frequency Relays, microprocessor-Based Frequency Relay, Formulating a Load-Shedding Scheme, Maximum Anticipated Overload, Number of Load-Shedding Step, Size of the Load Shed at Each Step, Frequency Settings, Time Delay, Special Considerations for Industrial System.

07 Hours

Requirement of protective relaying, zones of protection, Electromechanical relay,primary and backup protection, essential qualities of protective relaying, classification of Electromechanical protective relays
Non-directional and directional over current relays, IDMT and Directional characteristics. Buchholz relay, Negative Sequence relay, relay coordination, Microprocessor based over current relay – block

diagram approach

UNIT-III

Apparatus and line protection	**07 Hours**

Line Protection – Distance, Differential protection and Carrier current protection. Generator protection – protection against abnormal condition, stator and rotor protection Transformer Protection – Incipient fault–Differential protection, Feeder and Bus bar protection.
Developments in New Relaying Principles

Introduction, Traveling Wave Based Protection of Transmission Lines, Frequency Based Relaying , Series Compensated Line Protection, Introduction, The Degree of compensation, Voltage Profile of Series Compensated Line, Faults with Unbypassed Series Capacitors, Relay Problems Due to compensation, Voltage and Current Inversion, Problems in reach measurement, Protection of Series compensated line, Concept of Adaptive Relaying , Fault Location Algorithms.

Substation Protection	**03 Hours**

Introduction to substation architecture, automation and protection - Protection against over voltages – Causes of over voltage, Ground wires, Surge absorbers and diverters. Earthing - types. Insulation co-ordination.

Suggested List of Experiments

1.	Current -Time characteristics of fuse
2.	IDMT characteristics of non-directional OCR
3.	Characteristics of static over-voltage relay.
4.	DMT characteristics of static under-voltage relay.
5.	Microcontroller based OCR.
6.	Protection of transformers
7.	Generator protection

Demonstration Experiments

1.	Demonstration of Current -Time characteristics of fuse
2.	Demonstration of Microcontroller based OCR

Course Outcomes: At the end of the course student will be able to

1.	Describe the necessity of switches, fuses and circuit breakers.
2.	Describe the working principles of relay and necessity of digital relaying
3.	Explain the significance of frequency relay and to understand the different load shedding scheme
4.	Describe the working principle of various relays and suggest relay settings for different protective zones of transmission line.
5.	Apply protection schemes to protect lines,generators, transformers and induction motors.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2004-1.1	3	3	-	-	-	-	-	-	2		-	1	-	1
EE2004-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2004-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	1
EE2004-1.4	3	3	-	-	-	-	-	-	3	3	-	1	-	1
EE2004-1.5	3	3	-	-	-	-	-	-	2	2	-	1	-	1

	1: Low 2: Medium 3: High
TEXTBOOKS:	
1.	Sunil S.Rao, Switchgear & Protection, Khanna Publishers, (GS) ,13th edition, 2008
2.	Badriram & Viswa Kharma, “Power System Protection & Switchgear”, TMH, (GS), , 2nd edition,2013.
3.	Y G. Painthankar and S R Bhide, “Fundamentals of power system protection”, PHI publication, , 2nd edition, 2010.
4.	Bhavesh Bhalja, R.P Maheshwari, N.G.Chothani, “Protection and Switchgear”, Oxford University Press, 2nd edition, New Delhi, 2010.
5.	Ramesh Bansal, "Power System Protection in Smart Grid Environment", CRC Press, 1st Edition, 2019
REFERENCE BOOKS:	
1.	A. Chakarbarti, M.L. Soni and P.V. Gupta, U.S. Bhatnagar, “Power system engineering” , Published by Gagan Kanur, Dhanapat Rai and Co Pvt. Ltd,2013.
2.	Ravindarnath & Chandra, “Power System Protection & Switchgear”, New age Publications. (GS),1st edition,2011.
3.	Phadke A.G and J.S. Thorp, “Computer Relaying for Power Systems”, Research Study Press Ltd, John Wiley & sons, Taunton, UK, 1988.
4.	B.A Oza and R.P Mehta, “Power System Protection”, TMH Publication, 2013.
E Books / MOOCs/ NPTEL	
1.	NPTEL course on Power System Protection and Switchgear By Prof. Bhaveshkumar R. Bhalja, IIT Roorkee
2.	NPTEL Course on Power System Protection by By Prof. Ashok Kumar Pradhan, IIT Kharagpur
3.	NPTEL course on Digital Protection of Power System by Prof. Bhaveshkumar R. Bhalja, IIT Roorkee

NETWORK ANALYSIS

Course Code:	**EE2005-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE1001-2**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To familiarize the basic laws, theorems and the methods of analyzing electrical Circuits including coupled circuits.
2.	To explain the concept of resonance and coupling in electric circuits
3.	To familiarize the analysis of three-phase circuits
4.	To analyze the transient response of circuits with DC and sinusoidal AC input
5.	To synthesize the given signal in terms of basic signals
6	To solve and obtain the behavioral equation for a given network using Laplace transforms
7	To represent the output and input parameters of a given network using two port network parameters.

UNIT-I

Independent and Dependent sources	**08 Hours**
Source transformation, DC and AC multi-loop circuit analysis- mesh and node analysis (super mesh and super node included) for electric circuit with linearly dependent and independent sources. Coefficient of coupling, dot convention for coupled coils and analysis of coupled circuits.	
Resonance	**04 Hours**
Series and parallel resonance, Q factor, bandwidth.	
Unbalanced Three-phase systems	**03 Hours**
Analysis of three-phase unbalanced systems, neutral shift, calculation of real and reactive powers.	

UNIT-II

Transient behaviour and initial conditions	**04 Hours**
Behavior of circuit elements under switching. Conditions and their representations, evaluation of initial and final conditions in RL, RC and RLC circuits with AC and DC excitations,	
Waveform Synthesis	**04 Hours**
Impulse, Step, Ramp and sinusoidal signals. Synthesis of aperiodic and periodic signals and their Laplace Transforms	
Transform method of analysis	**04 Hours**
Review of Laplace transformation, Laplace Transform of network and time domain solution for RL, RC and RLC networks for ac and dc excitations.	
Two port networks	**03 Hours**
Short circuit admittance parameters(y), Open circuit impedance parameters(z), T parameters, h parameters, Relationship between parameter sets.	

UNIT-III

Network theorems	**10 Hours**
Network reduction, Star-Delta conversion, Superposition, Reciprocity, Thevenin's and Norton's theorem, Maximum power transfer theorem, Millman's theorem as applied to AC and DC circuits.	

Suggested List of Experiments

1.	Verification of KVL, KCL for multi-loop electrical circuits with DC/AC independent sources

	through simulation software
2.	Verification of KVL, KCL for multi-loop electrical circuits with DC / AC controlled dependent sources through simulation software.
3.	Analysis of series resonance concept and plot of current, impedance, X_L, X_C, phase angle vs frequency
4.	Analysis of parallel resonance concept and plot of current vs frequency.
5.	Analysis of First order R-L and R-C circuits
6.	Analysis of First order R-L and R-C circuits and second order RLC circuit through simulation software and validation of results using Laplace transform method.
7.	Verification of impedance/ admittance parameters of two port network through simulation software
8.	Verification of Thevenin's theorem
9.	Verification of Norton's theorem and Maximum power transfer theorem.
10.	Verification of Superposition and Reciprocity theorems

Course Outcomes: At the end of the course student will be able to

1.	Apply KCL & KVL to solve the DC and AC circuits including coupled circuits.
2.	(i) Analyze electrical resonance in a series and parallel networks (ii) Analyze the unbalanced three-phase circuits to compute current, voltage and power.
3.	(i) Analyze the initial and final conditions of a given network. (ii) Synthesize the given signal in terms of impulse, step, ramp and sinusoidal functions
4.	(i) Solve the given network to study the transient and steady state behavior using Laplace transform method (ii) Obtain the two port network parameters for a given networks
5.	(i) Reduce the given network using star – delta transformation (ii)Apply the network theorems to estimate steady state response for a given excitation

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ **Course Outcomes**													1	2
EE2005-1.1	3	3	-	-	2	-	-	-	2	2	-	1	-	3
EE2005-1.2	3	3	-	-	--	-	-	-	2	2	-	1	-	3
EE2005-1.3	3	3	-	-	-	-	-	-	2	2	-	1	-	3
EE2005-1.4	3	3	-	-	2	-	-	-	2	2	-	1	-	3
EE2005-1.5	3	3	-	-	2	-	-	-	2	2	-	1	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	W.H. Hayt and J.E Kemmerley, "Engineering circuit Analysis", McGraw Hill, 8th Edition 2014.
2.	Ravish R. Singh, "Network Analysis and Synthesis", McGraw Hill Education, 2017.
3.	A Chakrabarthi, "Electric circuits", Dhanpath Rai and company, 6th Edition.2014.

REFERENCE BOOKS:

1.	Charles K Alexander, Matthew N O Sadiku, "Fundamentals of Electric Circuits", Mc Graw Hill, 5th Edition, 2013.
2.	M.E Van Valkenberg, "Network Analysis", 3rd Edition, Series Volume: 7, Prentice Hall Publishers. 2014.
3.	Mahmood Nahvi, "Electric Circuits", Mc Graw Hill, 5th Edition, 2009.

E Books / MOOCs/ NPTEL	
1.	https://archive.nptel.ac.in/courses/108/105/108105159/
2.	https://www.coursera.org/learn/linear-circuits-dc analysis

INDUSTRIAL DRIVES AND APPLICATIONS

Course Code:	**EE3001-1**	**Course Type**	**IPCC**
Teaching Hours/Week (L: T: P: S)	**3:0:2:0**	**Credits**	**04**
Total Teaching Hours	**40+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1, EE2102-1, EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the basic principle of Industrial Drives, its requirements, its characteristics, selection and design and finally different applications.
2.	To model an Electrical Drive and understand its steady state, transient behavior
3.	To understand the need of industrial drives, its control and design of different parameters.
4.	To differentiate the AC and DC drives and their selection based on requirements, and their characteristics
5.	To apply the knowledge in selection of drives for real Industrial applications.

UNIT-I

AN INTRODUCTION TO ELECTRICAL DRIVES & ITS DYNAMICS	**12 Hours**

Electrical drives. Advantages of electrical drives. Parts of electrical drives, choice of electrical drives, status of dc and ac drives. Dynamics of electrical drives, Fundamental torque equation, speed torque conventions and multi-quadrant operation. Equivalent values of drive parameters, components of load torques, nature and classification of load torques, steady state stability, load equalization, numerical problems

Selection of motor power rating	**03 Hours**

Classes of motor duty, Starting and braking of DC shunt and series motor.

UNIT-II

CONTROL OF DC MOTOR DRIVES	**10 Hours**

Single phase fully controlled rectifier, control of dc separately excited motor, Single-phase half-controlled rectifier control of dc separately excited motor. multi-quadrant operation of dc separately excited motor fed from fully controlled rectifier. Rectifier control of dc series motor, chopper-controlled dc drives, chopper control of separately excited dc motor, Chopper control of series motor, numerical problems

INDUCTION MOTOR DRIVES	**05 Hours**

Stator voltage control variable voltage frequency control from voltage sources, voltage source inverter control, closed loop control, current source inverter control, current regulated voltage source inverter control, rotor resistance control, slip power recovery, speed control of single-phase induction motors, numerical problems

UNIT-III

SYNCHRONOUS MOTOR DRIVES	**07 Hours**

Operation form fixed frequency supply, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thyristor inverter.

INDUSTRIAL DRIVES	**03 Hours**

Rolling mill drives, cement mill drives and paper mill drives

Suggested List of Experiments

Simulation

1.	Simulation of single-phase half wave phase-controlled converter with R and R-L load
2.	using MATLAB.
3.	Simulation of single-phase full wave phase-controlled converter with R and R-L load using MATLAB
4.	To study open loop and closed loop control of BLDC motor.
5.	To study open loop and closed loop control of DC motor.
6.	To Study Simulation of Single Phase Full-Wave Bridge inverter on MATLAB.

Hardware

1.	To control speed of induction motor using stator voltage control.
2.	Speed control of DC shunt motor by armature voltage control method
3.	To study the speed control of induction motor by varying supply frequency

Course Outcomes: At the end of the course student will be able to

1.	Analyze basic principle of Industrial Drives and their selection based on source / load requirements
2.	Explain starting and braking of dc series and shunt motors
3.	Explain the operation of power electronic converters in DC drives.
4.	Develop steady / transient models of Induction motor drive to control using power electronics controllers
5.	Control the Synchronous Motor Drives using power electronics controllers. And apply the acquired knowledge in selection of drives for real world Industrial applications.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3001-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3001-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3001-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3001-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3001-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOK:

1. G.K Dubey, "Fundamentals of Electrical Drives"-2nd Edition, Narosa publishing house Chennai, 2010

REFERENCE BOOKS:

1. N.K De and P.K. Sen-, "Electrical Drives" PHI, 1st edition,2009
2. S.K Pillai, "A First Course On Electric Drives" Wiley Eastern Ltd 1990.
3. V.R. Moorthi, "Power Electronics, Devices, Circuits and Industrial Applications" "Oxford University Press, 2005.

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/108108077/
2. https://ocw.tudelft.nl/courses/electrical-machines-and-drives/?view=lectures

LINEAR CONTROL SYSTEMS

Course Code:	**EE3002-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**MA1003-1, MA2004-1, EE2005-1**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce modeling and analysis of electrical, electromechanical and mechanical systems.
2.	To familiarize the students with analytical and graphical techniques to study the system stability
3.	To make the students familiar with the time and frequency domain analysis of the system

UNIT-I

Modelling of systems	**08 Hours**
Mathematical modelling of physical system - electrical, mechanical, electromechanical systems, gear train, analogous system, Force voltage and force current analogy, Torque voltage and torque current analogy.	
Block diagrams and signal flow graphs	**03 Hours**
Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded)	
Time Response of feedback control systems	**04 Hours**
Standard test signals, Unit step response of first and second order systems, time response specifications of first & second order systems, steady–state static errors, and error constants.	

UNIT-II

Stability analysis	**03 Hours**
Concepts of stability, necessary conditions for stability, Routh- stability criterion, relative stability analysis.	
Root–Locus Techniques	**04 Hours**
Introduction, root locus concepts, construction of root loci, effect of addition of poles and zeroes	
Frequency domain analysis	**08 Hours**
Frequency response specification, correlation between time and frequency response, Bode plots. All pass, minimum & non-minimum phase systems, assessment of relative stability using Bode plots, determination of transfer functions from Bode plots.	

UNIT-III

Compensators and Controllers	**04 Hours**
Compensators, lead, lag, lag-lead networks, controllers P, PI, PID (qualitative analysis)	
State Space Analysis:	**06 Hours**
Definition of state, state variables, state vectors and state space. State-Space equations and Block diagram representation, State space equations and block diagram of mechanical and electrical systems. Correlation between transfer functions and state-space equations. State-Space representation of scalar differential equation systems.	

Suggested List of Experiments

1.	Introduction to MATLAB and Simulink
2.	Mathematical modeling of physical system and applying Force Voltage and Force Current analogy using differential equation
3.	Mathematical modeling of physical system and applying Force Voltage and Force Current analogy in 's' domain

4.	Transient analysis of an armature-controlled DC motor
5.	Time response analysis of first order system
6.	Time response analysis of second order system and finding performance parameters
7.	Root locus and bode plot of a given system
8.	Lead, lag and lag-lead compensator
9.	Effect of PD, PI and PID controller
10.	Conversion of transfer function to state space model

Course Outcomes: At the end of the course student will be able to

1.	Develop mathematical models of electrical, mechanical and electromechanical linear systems to study the system dynamics.
2.	Perform time response analysis of first and second order systems to determine performance parameters
3.	Apply Routh- stability criterion and root locus technique to determine system stability
4.	To apply bode plot to assess system stability.
5.	Develop various compensators, controllers and determine state space representation for the giv transfer function

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2
EE3002-1.1	3	3	-	-	-	-	-	-			-	1	-	2
EE3002-1.2	3	3	-	-	2	-	-	-	2	2	-	1	-	2
EE3002-1.3	3	3	-	-	2	-	-	-	2	2	-	1	-	2
EE3002-1.4	3	3	-	-	2	-	-	-	2	2	-	1	-	2
EE3002-1.5	3	3	-	-	2	-	-	-	2	2	-	1	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. K. Ogata, "Modern Control Engineering ", Pearson Education Asia/ PHI, 4th Edition, 2002.
2. J. Nagarath and M.Gopal, "Control Systems Engineering", New Age International (P) Limited, Publishers, 5th edition – 2007

REFERENCE BOOKS:

1. Richard C. Dorf and Robert H Bishop, "Modern Control Systems Book", Prentice Hall, 12 edition
2. Norman S. Nise, "Control Systems Engineering", Wiley India Pvt. Ltd, 7th edition, 2014

E Books / MOOCs/ NPTEL

1. https://onlinecourses.nptel.ac.in/noc21_de08/preview
2. https://onlinecourses.nptel.ac.in/noc20_ee22/preview

SIGNAL ANALYSIS AND PROCESSING

Course Code:	**EE3003-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**MA2008-1, MA2004-1, EE2005-1**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the basic operations on signals and properties of systems.
2.	To explain the properties of linear time invariant systems in terms of impulse response description.
3.	To know the Fourier representation of continuous time & discrete time periodic & aperiodic signals and their properties.
4.	To evaluate DFT of various signals using its properties.
5.	To evaluate the effective computation of DFT using fast fourier Transform algorithms.
6.	To know the importance of sampling theorem in signal processing.
7.	To design infinite impulse response digital filters using bilinear transformation technique
8.	To understand the procedures used for the design of linear phase FIR filters using rectangular window

UNIT-I

Introduction: — **06 Hours**

Continuous time and Discrete time signals, transformation of independent variables, exponential and sinusoidal signals, unit impulse, unit step and Sine functions. The sampling theorem, The effect of under sampling: Aliasing, Discrete time processing of continuous time signals, Sampling of discrete time signals, Quantization.

Continuous time and Discrete time systems — **09 Hours**

Continuous time and Discrete time systems, Properties of system. Continuous time LTI systems: The Convolution Integral. Discrete time LTI system: Convolution Sum. Properties of LTI system (Numerical excluded), Causal LTI systems described by Difference and Differential equations.

UNIT-II

Fourier Representation of Periodic Signals — **08 Hours**

Introduction, Fourier representation of continuous-time periodic signals in exponential form, Convergence of the Fourier series. Fourier representation of Discrete-time periodic signals
The Continuous-time Fourier transform: Properties of continuous-time Fourier transform, The Discrete-Time Fourier Transform: Representations of aperiodic signals, duality. Systems characterized by Linear Constant Coefficient Difference equations

Discrete Fourier Transform — **07 Hours**

Fourier representation of Finite duration sequences: Discrete Fourier Transform (DFT), Properties of DFT. Computation of DFT: Decimation-in-Time FFT algorithms, (Radix-2 Algorithm), Decimation-in-Frequency FFT algorithms (Radix-2 Algorithm),

UNIT-III

Structure for discrete time systems — **10 Hours**

Block diagram representation of Linear Constant coefficient difference equations. Basic structures for IIR systems(Direct Form I & II only), Basic Structure of FIR systems. (Direct forms and Cascaded Structures). Design of Discrete time IIR filters from continuous time filters using Bilinear

Transformation (Butterworth LPF only). Frequency Transformation of Low pass IIR filters (theory only). Design of FIR filters by rectangular window. (Low Pass Filter design only)

Suggested List of Experiments

1.	Representation of basic signals and verification of properties of signals.
2.	Realization of Sampling theorem and Aliasing
3.	Finite and Infinite Response of an LTI System.
4.	Linear & Circular Convolution of two given sequences.
5.	Realization of Dirichlet Conditions for Fourier Series.
6.	Verification of Properties of Continuous time Fourier transform.
7.	Verification of DFT properties: i) Frequency shift ii) Time shift iii) Linearity iv) Auto Correlation & Cross Correlation v) Parseval's Theorems.
8.	Computation of N point DFT of a given sequence.
9.	Design and Implementation of Analog and Digital IIR filter to meet the given specifications for the Low pass filter.
10.	Design and implementation of FIR filter to meet the given specifications using Rectangular LPF.

Course Outcomes: At the end of the course student will be able to

1.	Analyse signals and systems to study the behavioural aspects & determine the impulse response of CT & DT systems using convolution.
2.	Analyse Continuous and Discrete LTI systems to determine the impulse response and convolution.
3.	Apply Fourier technique to obtain the frequency domain representation of continuous-time & discrete-time aperiodic signals
4.	Apply FFT to compute the frequency domain representation of discrete time sequence
5.	Design of IIR and FIR filters to determine the filter coefficients for a given specification

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes														
EE3003-1.1	3	3	-	-	3	-	-	-	2	2	-	1	-	
EE3003-1.2	3	3	-	-	3	-	-	-	2	2	-	-	-	2
EE3003-1.3	3	3	-	-	3	-	-	-	2	2	-	-	-	2
EE3003-1.4	3	3	-	-	3	-	-	-	2	2	-	-	-	2
EE3003-1.5	3	3	3	-	3	-	-	-	2	2	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Alan V Oppenheim, Alan S. Willsky and S. Hamid Nawab, "Signals and Systems", PHI, 2nd edition, 2009.
2. Alan V Oppenheim and Ronald W Schafer, "Discrete time signal processing", PHI, 5th Indian Reprint, 2015

REFERENCE BOOKS:

1. John G Proakis and Dimtris G Manolakis, "Digital Signal Processing Principles, Algorithms and Application", Electronic Industry Press, 2013, 4TH Edition.
2. Simon Haykin and Barry Van Veen, "Signals and Systems," Wiley India Pvt Ltd, 2nd Edition

	2008
3.	S.Narayan Iyer, “Signals and systems”, Cengage Learning,India,2011
E Books / MOOCs/ NPTEL	
1.	Signal Processing: Continuous and Discrete on MIT Open courseware
2.	NPTEL Course on Principles of Signals and Systems by Prof. Aditya K. Jagannatham, IIT Kanpur
3.	NPTEL Course on Digital Signal Processing by Dr.C. S. Ramalingam, IIT Madras

Professional Core Courses (Theory)

ANALOG SIGNAL PROCESSING

Course Code:	**EE2101-1**	**Course Type**	**PCC**
Teaching Hours/Week (L:T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To analyze the differential & operational amplifiers and various parameters associated with them
2.	To understand the structural properties, characteristics and operation of MOSFET
3.	To study the MOSFET parameters when used as an amplifier and as a switch
4.	To use MOSFET as a single stage amplifier and analyze its behavior at various frequencies
5.	To introduce the concept of feedback and analyze the oscillator circuits using MOSFET

UNIT-I	
Operational Amplifier	**03 Hours**
Op-Amp internal architecture. Ideal and practical Op-Amp. Offset error voltages and currents. OP-AMP as an AC Amplifier: Capacitor Coupled Voltage Follower, non-inverting amplifier, inverting amplifier, and difference amplifier. Effect on input impedance and its improvement. Setting upper cut-off frequency, Use of single polarity supply.	
OP-AMP in Signal Processing Circuits	**05 Hours**
Precision Half wave and full wave rectifiers, limiting circuits, clamping circuits, peak detectors, sample and hold circuits.: Op-Amps in Switching, Differentiating, and Integrating Circuits, crossing detectors, inverting Schmitt trigger circuits	
MOSFET	**03 Hours**
Device structure and Physical operation, I-V Characteristics	
MOSFET as an amplifier and as a switch	**04 Hours**
Large signal operation, Graphical derivation of the transfer characteristics, operation as a switch, operations as a linear amplifier, Analytical expressions.	
UNIT-II	
Biasing in MOS Amplifier circuits	**04 Hours**
Biasing by Fixing VGS, biasing by fixing VGS and connecting a resistance in the source, Biasing using a Drain-to-gate feedback amplifier, Biasing using a constant current source.	
Small-signal operation and models	**04 Hours**
DC bias point, signal current in the drain terminal, voltage gain, DC analysis and signal analysis, small signal equivalent, Transconductance, T equivalent circuit model.	
Single Stage MOS Amplifiers	**04 Hours**
Basic Structure, characterizing amplifiers, Common source amplifier, CS amplifier with a source resistance, Common gate amplifier, Common drain amplifier.	
MOSFET Internal Capacitances and high frequency model	**03 Hours**
Gate capacitive effect, junction capacitances, high frequency MOSFET model, Unity- Gain frequency, Circuit operation of CMOS Logic Inverter	
UNIT-III	
MOS Amplifiers	**04 Hours**
Frequency Response of CS amplifier, Miller effect	
Feedback Amplifiers & Oscillators	**04 Hours**

General Feedback structure, Properties of negative feedback, Feedback topologies, FET based RC phase shift oscillator.

FET Differential Amplifiers	**02 Hours**
MOS Differential pair with common mode and differential input voltage, Small-signal operation of MOS Differential pair	

Course Outcomes: At the end of the course student will be able to

1.	Analyze the differential and operational amplifiers to compute circuit parameters
2.	Analyze internal structure and working of MOSFET to infer the operating characteristics
3.	Analyze the large-signal behavior of the MOSFET, design bias circuits to locate operating point and small-signal operation to obtain the transconductance
4.	Analyze CS, CG & CD MOSFET single-stage amplifier circuits to obtain performance parameters
5.	Perform frequency sweep on CS MOS amplifier circuit to obtain the response curve and analyze feedback concepts to design oscillator circuits

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2101-1.1	1	2	3	-	2	-	-	-	1	-	-	-	-	-
EE2101-1.2	1	2	3	-	2	-	-	-	1	-	-	-	1	1
EE2101-1.3	1	2	3	-	2	-	-	-	1	-	-	-	-	1
EE2101-1.4	2	3	-	-	2	-	-	-	1	-	-	-	1	1
EE2101-1.5	1	2	3	-	2	-	-	-	1	-	-	-	1	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Sedra /Smith, "Microelectronic Circuits" 6th Edition, Oxford University Press-New Delhi,2013.
2.	David A Bell, "Operational Amplifier and Linear IC's", Oxford University Press-New Delhi, 3rd Edition, 2011.

REFERENCE BOOKS:

1.	Behzad Razavi, "Fundamentals of Microelectronics," Wiley & Son, 2014
2.	Nashelesky & Boylestead, "Electronic Devices & Circuit Theory", PHI, 11th Edition.2015.
3.	Ramakanth Gayakwad, "Operational Amplifiers and Linear IC's", 4th edition — Prentice Hall, 2000.
4.	Jacob Millman & Christos C. Halkias, "Integrated Electronics", McGraw Hill Publications, 2nd Edition, 2011

E Books / MOOCs/ NPTEL

1.	https://ocw.mit.edu/courses/6-101-introductory-analog-electronics-laboratory-spring-2007/
2.	https://onlinecourses.nptel.ac.in/noc20_ee89/preview

ELECTRICAL MACHINES I

Course Code:	**EE2102-1**	**Course Type**	**PCC**
Teaching Hours/Week (L:T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the principle, types and analysis of the performance of single phase transformer
2.	To get introduced the concept of testing the transformer for its efficiency and regulation.
3.	To understand the construction, types, and analysis of the three phase induction machine.
4.	To study various tests performed on an induction machine.
5.	To know various starting methods of a three phase induction machine.
6.	To comprehend the theory and types of single phase induction motor.

UNIT-I

Single phase transformers: analysis & performance	**06 Hours**
Review of construction and working principle, ideal & practical transformers on no load, EMF equation, transformer on load phasor diagrams, equivalent circuit, losses, power & all day efficiency, Regulation.	
Testing	**02 Hours**
Polarity test, SC, OC test, Sumpner's test.	
Parallel operation	**02 Hours**
With equal voltage ratios and unequal voltage ratios.	
Autotransformers	**02 Hours**
Principle of autotransformers, calculation of saving of copper, advantages/disadvantages.	
Three-phase transformers	**03 Hours**
Operational aspects, 3-phase transformer connection including open delta, bank of 1-phase transformer for 3-phase operation, Tertiary winding and its importance.	

UNIT-II

Three-Phase Induction Machines	**03Hours**
Operating principle, Concept of rotating magnetic field, Classification & types.	
Analysis and Performance of Three-Phase Induction Motor	**12 Hours**
Induction motor on no load & load, efficiency and losses, phasor diagram, power factor evaluation, equivalent circuit. HP, Torque, slip torque characteristics covering regions of motoring generating & Braking, Induction generator. No load & BR tests.	

UNIT-III

Double Cage and Deep Bar Rotor Induction Motors, Starting of Induction Motor	**06 Hours**
Equivalent circuit and performance of double cage & deep bar motors, cogging and crawling of induction motors. Need for starter, DOL, Y-Δ autotransformer starting, rotor resistance starting.	
Single-Phase Induction Motor	**04 Hours**
Double field revolving theory, Principle of operation Types of single- phase induction motor - split phase, capacitor start.	

Course Outcomes: At the end of the course student will be able to

1.	Appreciate the construction of single-phase transformer and conduct tests to determine efficiency & regulation.
2.	Describe the operation of autotransformers and analyze various three-phase transformer configurations.
3.	Describe the constructional features of different types of three-phase Induction motors.
4.	Comprehend the characteristics of three-phase induction machine.
5.	Appreciate various starting methods of a three-phase induction motor and operating principle of single-phase induction motor.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2102-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	1
EE2102-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	1
EE2102-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2102-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	1
EE2102-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers,7th edition,201.
2. A. Langsdortf, “Theory of alternating current machine”, TMH,2nd edition,2004.
3. Ashfaq Husain, “Electrical Machines”, Dhanapathrai & co,2nd edition,2014.

REFERENCE BOOKS:

1. M.G Say, “Performance & design of AC machines”, CBS publishers,3rd edition,2002.
2. Nagarath and Kothari, “Electrical Machine”, TMH,4th edition,2010.
3. Kosow, “Electrical Machines and Transformers”, 2/e, PHI,1990.
4. Transformers, BHEL, Tata Mc Graw Hill ,2nd edition,2003.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108105155
2. https://onlinecourses.nptel.ac.in/noc22_ee06/preview
3. https://ocw.mit.edu/courses/6-685-electric-machines-fall-2013/pages/course-notes/

ELECTROMAGNETIC FIELDS

Course Code:	**EE2103-1**	**Course Type**	**PCC**
Teaching Hours/Week (L:T: P: J)	**3:0:0:1**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations.
2.	To evaluate the energy and potential due to a system of charges
3.	To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics
4.	To study the magnetic fields and magnetic materials
5.	To study the time varying fields and propagation of waves in different media

UNIT-I

Coulomb's Law and Electric field intensity	**04 Hours**
Experimental law of coulomb, Electric field intensity, Field due to continuous volume charge distribution, Field of a line charge (only theory).	
Electric flux density, Gauss's law and Divergence	**04 Hours**
Electric flux density, Gauss's law and Divergence, Vector operator ∇ and Divergence theorem.	
Energy and Potential	**05 Hours**
Energy expanded in moving a point charge in an electric field, the line integral, Definition of Potential difference and Potential, the potential field of a point charge and system of charges, Potential gradient.	
Conductors	**02 Hours**
Current and current density, Continuity of current, Metallic Conductors, Conductor properties and boundary conditions.	

UNIT-II

Dielectrics and Capacitance	**02 Hours**
Boundary conditions for perfect dielectrics, Capacitance.	
Poisson's and Laplace's equations	**03 Hours**
Derivation of Poisson's and Laplace's equations.	
The steady magnetic field	**05 Hours**
Biot–Savart's law, Ampere's circuital law, curl, Stokes theorem, Magnetic flux and magnetic flux density, Scalar and vector magnetic potentials.	
Magnetic forces, Magnetic Materials and Inductance	**05 Hours**
Force on a moving charge, Magnetic boundary conditions, Inductance.	

UNIT-III

Time varying fields and Maxwell's equations	**06 Hours**
Faraday's law, Displacement current, Maxwell's equation in point and integral form.	
Transmission Lines	**04 Hours**
Physical description of Transmission line propagation, Transmission line equations, Lossless propagation, Lossless propagation of sinusoidal voltages, voltage standing wave ratio.	

Course Outcomes: At the end of the course student will be able to

1.	State and apply the Coulomb's, Gauss's Law to determine the electric field intensity resulting from various charge distributions.
2.	Describe the electric potential to compute electric field intensity and analyze the boundary conditions for various interfaces to understand the variation in electric filed intensity.
3.	Apply Poisson's and Laplace's equations to calculate capacitance of various geometrics and apply Biot- Savart's, Ampere's Law to compute magnetic field intensity.
4.	Apply the concept of magnetic forces, boundary conditions and Maxwell's equations to determine inductance and parameters of time varying fields.
5.	Describe plane wave reflection and transmission at the boundaries to study the wave propagation and skin effect.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2103-1.1	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2103-1.2	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2103-1.3	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2103-1.4	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2103-1.5	3	3	-	-	-	-	-	-	2	2	-	1	2	2

1: Low 2: Medium 3: High

TEXTBOOK:

1. William H. Hayt Jr. and John A. Buck, "Engineering Electromagnetics" Tata McGraw-Hill, 8th edition, 2017.

REFERENCE BOOKS:

1. John Krauss and Daniel A. Fleisch, "Electromagnetics with Applications", McGrawHill, 5th edition, 1999.
2. Matthew N. O. Sadiku, "Elements of Electromagnetics", OUP USA
3. Edward C. Jorden and Keith G Balmain, "Electromagnetic Waves and Radiating Systems" Prentice – Hall of India / Pearson Education, 2nd edition, 1968.
4. David K. Cheng, Field and Waves Electromagnetics", Pearson Education Asia,2nd edition – 1989.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108104087

GENERATION TRANSMISSION AND DISTRIBUTION

Course Code:	**EE2104-1**	**Course Type**	**PCC**
Teaching Hours/Week (L:T: P: S)	**3:0:0:1**	**Credits**	**03**
Total Teaching Hours	**40+0+0+√**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the concepts of various methods of generation of power
2.	To find various parameters of economic aspects
3.	To calculate the parameters of the transmission line for different configurations and assess the performance of the line
4.	To understand the characteristics & performance of power transmission lines.
5.	To understand the concept of underground cables and distribution systems

UNIT-I

Electrical Power Generation — **07* Hours**

Hydro Power generation-selection of site, classification of hydroelectric plants, general arrangement and operation, hydroelectric plant power station structure and control.
Thermal Power generation- Introduction, main parts, working, plant layout, Diesel Electric plants, Gas turbine plants-components, layout, advantages over steam turbine plant.
Nuclear Power Station- Introduction, Adverse effects of fossil fuels, components of reactors, Description of fuel sources, Pros and Cons of nuclear power generation, Safety of nuclear.

Economic Aspects — **06* Hours**

Introduction, Terms commonly used in system operation, diversity factor, load factor, plant capacity factor, plant use factor, plant utilization factor, loss factor, load duration curve, energy load curve, interconnection of power station, Effect of variable load on power system, classification of costs, cost analysis. Interest and Depreciation, Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Most economical power factor, importance of high load factor.

Typical transmission & distribution systems scheme — **02 Hours**

General layout of power system, Standard voltages for transmission: HVAC, EHVAC, UHVAC, and Advantage of high voltage transmission. Feeders, distributors & service mains.

UNIT-II

Sag calculation in conductors — **06* Hours**

Sag calculation for a) suspended on level supports b) support at different levels. Effect of wind & ice tension & sag at erection, line vibration damper.
Insulators: Types, Material used: porcelain, toughened glass and polymer (composite), potential distribution over a string of suspension insulators. String efficiency & methods of increasing strings efficiency, Arcing horns. Testing of insulators

Line parameters — **05 Hours**

Calculation of inductance of single phase, 3phase lines with equilateral & unsymmetrical spacing. Inductance of composite conductor lines (GMR and GMD), capacitance calculation for single circuit and double circuit three-phase line with equilateral & unsymmetrical spacing, Bundle conductor and its advantages, Double circuit and transposed lines, Advantages of single circuit and double circuit lines.

Characteristics & performance of power transmission lines	**05 Hours**
Classification of lines, Transmission line model for Short transmission lines, medium transmission lines- nominal T, end condenser and pi models, long transmission lines, line regulation. Ferranti effect, ABCD constants of transmission lines. **Corona:** Phenomena, Methods of reducing corona	
UNIT-III	
Underground cables	**03* Hours**
Types, material used, insulation resistance, thermal rating of cables, charging current, Grading of cables, capacitance grading.	
Distribution	**06* Hours**
Requirements of power distribution, ac distribution - radial & ring main systems, calculation for concentrated loads. Introduction to HVDC transmission and FACTS, Application of HVDC and FACTS	

Course Outcomes: At the end of the course student will be able to

1.	Illustrate methods of generation of electrical power and their pros and cons
2.	Appreciate the economic aspects of electrical power and typical transmission & distribution systems scheme.
3.	Demonstrate the concepts associated with overhead transmission line and insulators
4.	Explain the characteristics & performance of power transmission lines.
5.	Interpret the concepts associated with underground cables and introduce the concept of FACTS and HVDC

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2104-1.1	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2104-1.2	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2104-1.3	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2104-1.4	3	3	-	-	-	-	-	-	2	2	-	1	2	2
EE2104-1.5	3	3	-	-	-	-	-	-	2	2	-	1	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. S. M. Singh, “Elements of Power Generation, Transmission and Distribution”, 2nd edition PHI, New Delhi. 2008
2. A. Chakarbarti, M.L. Soni and P.V. Gupta, U.S. Bhatnagar, “Power system engineering”, Published by Gagan Kanur, Dhanapat Rai and Co Pvt. Ltd,2013.
3. M.V. Deshpande, Elements of Power Station Design, 1st edition, PHI learning, 2009.
4. S. L. Uppal “Electrical Power: Generation, Transmission, Distribution, Switchgear and Protection, Utilization of Electrical Energy and Electric Traction” Khanna Publishers,15th edition, 1995.

REFERENCE BOOKS:

1. Sivanagaraju S. Satyanarayana S.,” Electric Power Transmission and Distribution” Pearson Learning, New Delhi, 2008.

2.	Gupta J. B.," Transmission and Distribution of electrical energy", S.K. Kataria & Sons, New Delhi, 2012.
3.	W.D. Stevenson, "Elements of Power System Analysis", 4th edition, 1994,.Mc.Graw - Hill. Comp. Ltd.
E Books / MOOCs/ NPTEL	
1.	https://nptel.ac.in/courses/108102047

POWER ELECTRONICS

Course Code:	**EE3101-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1, EE2101-1**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the types and characteristics of power semiconductor devices
2.	To describe the principle of operation of AC voltage controller
3.	To get acquainted with the different types of chopper configurations and methods of control.
4.	To understand the operation of controlled rectifier circuits and performance analysis.
5.	To understand the principle of operation of single-phase and three-phase inverter circuits.

UNIT-I

Introduction	**03 Hours**
Introduction, Power Semiconductor Devices: Applications of Power Electronics, Power semiconductor devices, Control Characteristics. Types of power electronic circuits. Peripheral effects.	
Power Semiconductor Devices	**08 Hours**
Power MOSFET's – static characteristics, switching characteristics, gate drive. IGBT- static characteristics, switching characteristics, di/dt and dv/dt limitations. Isolation of gate and base drives. Thyristor: SCR- static characteristics, turn on and off characteristics, thyristor firing circuit using UJT, commutation- natural and forced (LC commutation only), Static characteristics of TRIAC, DIAC	
AC Voltage Controllers	**04 Hours**
Introduction. Principle of ON-OFF and phase control. Single -phase bidirectional controllers with R and R-L loads	

UNIT-II

DC Choppers	**08 Hours**
Introduction. Principle of step-down and step-up chopper with R-L load. Performance parameters. Chopper classification. Analysis of impulse commutated thyristor chopper (only qualitative analysis)	
Controlled Rectifiers	**07 Hours**
Introduction. Principle of phase controlled converter operation. Single- phase and three phase semi-converters & Full converters.	

UNIT-III

Inverters	**10 Hours**
Introduction, Principle of operation, Performance parameters, Single -phase bridge inverters. Three phase inverters. Voltage control of single-phase inverters – single pulse width, multiple pulse width, and sinusoidal pulse width modulation. Current source inverters. Variable D.C. link inverter	

Course Outcomes: At the end of the course student will be able to

1.	Describe the characteristics of power semiconductor devices used in various Power Electronic Applications
2.	Describe the principle of operation of AC voltage controller to study its parameters

3.	Analyze the various DC choppers to evaluate their performance parameters.
4.	Analyze various controlled rectifier configurations to regulate dc voltage and calculate their performance parameters.
5.	Comprehend the operation of single and three phase inverter circuits to obtain desired AC voltage and analyze various associated parameters.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3101-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE3101-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE3101-1.3	1	2	3	-	-	-	-	-	-	-	-	-	-	2
EE3101-1.4	1	2	2	-	-	-	-	-	-	-	-	-	2	2
EE3101-1.5	1	2	3	-	-	-	-	-	-	-	-	-	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. M.H.Rashid "Power Electronics", 3Rd Edition, P.H.I. /Pearson, New Delhi, 2014.

REFERENCE BOOKS:

1. L.Umanand, "Power Electronics: Essentials & Applications", Wiley Publishers, 2009.
2. P.S Bimbra, Power Electronics, Fifth Edition, Khanna Publishers, 1990.
3. Ned Mohan, Tore M. Undeland, and William P. Robins, "Power Electronics – Converters, Applications and Design", Third Edition, John Wiley and Sons. 2010.

E Books / MOOCs/ NPTEL

1. NPTEL Course on Power Electronics By Prof. G.Bhuvaneshwari, IIT Delhi
2. Power Electronics, IIT Bombay , Prof. B.G. Fernandes, Prof. Kishore Chatterjee, https://nptel.ac.in/courses/108101038

POWER SYSTEM ANALYSIS AND STABILITY

Course Code:	**EE3102-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2005-1, EE2001-1, EE2102-1**		

**One additional tutorial class will be allotted every week*

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the per-unit system and explain its advantages.
2.	To understand the concept of one-line diagram and its application in the power system.
3.	To derive impedance & reactance diagrams and compute the per-unit quantities.
4.	To understand the response of a synchronous machine under symmetrical short circuit conditions.
5.	To resolve unbalanced three-phase quantities to symmetrical components.
6.	To understand the concept of sequence networks to solve various unsymmetrical faults.
7.	To learn the dynamics of a synchronous machine and derive the swing equation.
8.	To understand the equal-area criterion for the evaluation of stability of a sample system.

UNIT-I

Representation of Power System Components — **09 Hours**

Steady-state models of Transmission line, Synchronous machines, Transformer, and Load. One-line diagram, Impedance diagram, per unit notation, Selection, and change of base for per unit quantities, per unit Impedance diagram of power system, Power flow through Transmission line.

Symmetrical Three-Phase Faults — **06 Hours**

Transients in RL series circuits, short-circuit current and reactance of synchronous machine on no-load, Internal voltage of loaded synchronous machine under transient conditions, symmetric short circuit MVA calculations, short-circuit current computation through Thevenin's theorem, Problems

UNIT-II

Symmetrical Components — **08 Hours**

Symmetrical component transformation, Resolution of unbalanced phasors into their symmetrical components and vice-versa, Power in terms of symmetrical components, Phase shift of symmetrical components in Star – Delta transformer bank. Positive, Negative and Zero Sequence impedances and Sequence networks of power system elements (Transmission line, Synchronous machine and Transformer).

Unsymmetrical Faults — **07 Hours**

Symmetrical component analysis of Unsymmetrical faults: Line-To-Ground (L-G), Line-To-Line (L-L), Double Line-To-Ground (L-L-G) faults on an Unloaded Alternator and Power System with and without fault impedance and connections of sequence networks. Open conductor faults in power systems.

UNIT-III

Power System Stability — **10 Hours**

Steady-state and Transient stability, Rotor dynamics and the Swing equation, Power angle equation. Equal – Area criterion of stability and its application for transient stability evaluation. Numerical solution of swing equation by point-by-point method & Runge-Kutta 4th order method.

Course Outcomes: At the end of the course student will be able to

1.	Model the power system components to construct per unit impedance diagram
2.	Analyze symmetrical three phase faults in power system to determine short circuit kVA.
3.	Apply the concept of symmetrical components to calculate sequence components
4.	Analyze the power system using sequence networks for unsymmetrical faults.
5.	Analyze dynamics of synchronous machine to evaluate transient stability.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3102-1.1	3	3	-	-		-	-	-	-	-	-	1	-	1
EE3102-1.2	3	3	-	-		-	-	-	-	-	-	1	-	2
EE3102-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	2
EE3102-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	2
EE3102-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Nagrath and Kothari, "Modern Power System Analysis", 4TH edition, MHE 2011
2.	John J Grainger, William D Stevenson, "Power System Analysis", Tata McGraw-Hill Education India, 2014
3.	W.D Stevenson, "Elements of Power System Analysis". 4THedition,TMH,2001

REFERENCE BOOKS:

1.	Arthur Bergen "Power System Analysis", 2nd edition, Pearson , 1999

E Books / MOOCs/ NPTEL

1.	NPTEL Course on Power system analysis by Prof. Debapriya Das, IIT Kharagpur
2.	NPTEL Course on Computer-Aided Power System Analysis by Prof. Biswarup Das, IIT Roorkee

Professional Core Courses (Lab)

ANALOG SIGNAL PROCESSING LABORATORY

Course Code:	**EE2601-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**0+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To design and test OpAmp circuits
2.	To study the MOSFET characteristics
3.	To design and test biasing circuits of MOSFET.
4.	To use MOSFET as an amplifier and verify its frequency response.
5.	To design and test MOSFET based oscillator circuit.

Suggested List of Experiments

1.	Design and testing of capacitor couple voltage follower and inverting amplifier for gain, frequency response, Zin.
2.	Design and testing of capacitor coupled non inverting and difference amplifier for gain, frequency response and Zin calculation
3.	Design and testing of unipolar Op-Amp circuits for gain, frequency response and Zin calculations
4.	Study of MOSFET characteristics and determine transconductance & output resistance.
5.	Design different types of biasing circuits and validate the operating point
6.	Design Common Source (CS) MOSFET amplifier to determine frequency response
7.	Application of MOSFET as a switch.
8.	Design MOSFET source follower to determine input & output impedance
9.	Design and test MOSFET based RC phase shift oscillator.
10.	Design MOSFET based differential amplifier to determine differential and common mode gains.

Course Outcomes: At the end of the course student will be able to

1.	Use of Op-Amp to design application specific circuit
2.	Use of Op-Amp to design unipolar application specific circuit
3	Verify MOSFET characteristics and biasing circuits to validate operating point.
4.	Use MOSFET for amplifier applications to determine the gain, frequency response, input & output impedances.
5.	Design MOSFET based oscillator circuits to generate required frequency signals

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2601-1.1	3	3	-	-	-	-	-	-	2	2	-	-	-	2
EE2601-1.2	3	3	-	-	-	-	-	-	2	2	-	-	-	2
EE2601-1.3	3	3	-	-	-	-	-	-	2	2	-	-	-	2
EE2601-1.4	3	3	-	-	-	-	-	-	-	2	-2	-	-	2
EE2601-1.5	3	3	-	-	-	-	-	-	-	2	2	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Sedra /Smith, "Microelectronic Circuits" 6th Edition, Oxford University Press-New Delhi,2013.
2.	David A Bell, "Operational Amplifier and Linear IC's", Oxford University Press-New Delhi, 3rd Edition, 2011.

ELECTRICAL MACHINES– I LABORATORY

Course Code:	**EE2602-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**0+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To get familiarized with the methods of testing transformer efficiency and regulation.
2.	To understand torque-slip characteristics of an induction machine.
3.	To perform speed control of three-phase slip-ring induction motor.
4.	To get acquainted with parallel operation and three-phase connections of single-phase transformers.

Suggested List of Experiments

1.	Load test on single phase transformer.
2.	OC, SC test on single-phase transformer, predetermination of efficiency & regulation.
3.	Sumpner's test.
4.	Parallel operation of two dissimilar (different KVA) Single -phase transformers.
5.	Polarity test & connection of three- single-phase transformers in star – delta and determination of efficiency & regulation – for balanced direct loading for UPF.
6.	Three-phase power transformation by two transformers with open delta.
7.	Load test on 3-phase induction motor- performance evaluation (Torque- speed, BHP-efficiency, BHP-PF, slip- BHP).
8.	Speed control of 3-phase slip-ring induction motor- rotor resistance control (performance for at least two different rotor resistance values).
9.	Load test on induction generator.
10.	Load test on single-phase induction motor.

Course Outcomes: At the end of the course student will be able to

1.	Perform suitable tests on transformer to predetermine/ determine efficiency and regulation.
2.	Operate two single-phase transformers in parallel to compute load sharing.
3.	Connect three single-phase transformers banks to obtain different three-phase connections.
4.	Perform suitable test to analyze torque-slip characteristics of an induction machine. .
5.	Apply rotor resistance technique to control the speed of three-phase slip-ring induction machine.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2602-1.1	3	3	-	-	-	-	-	-	2	2	-	-	-	-
EE2602-1.2	3	3	-	-	-	-	-	-	2	2	-	-	-	-
EE2602-1.3	3	3	-	-	-	-	-	-	2	2	-	-	-	-
EE2602-1.4	3	3	-	-	-	-	-	-	2	2	-	-	-	-
EE2602-1.5	3	3	-	-	-	-	-	-	2	2	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers,7th edition,201.

2.	A. Langsdorf, "Theory of alternating current machine", TMH,2nd edition,2004.
3.	Ashfaq Husain, "Electrical Machines", Dhanapathrai & co,2nd edition,2014.

HIGH VOLTAGE ENGINEERING LABORATORY

Course Code:	**EE3601-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**0:1:1:0**	**Credits:**	**01**
Total Teaching Hours:	**0+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE2104-1, EE2102-1, EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To find the breakdown voltage and dielectric strength of transformer oil
2.	To familiarize the concepts of earth resistance measurements
3.	To understand HVDC and HVAC measurements using standard rod and spheres
4.	To study field mapping using electrolytic tank
5.	To get acquainted with partial discharge testing methods

Suggested List of Experiments

1.	Break-down voltage of transformer oil
2.	Measurement of Earth Resistance of High Voltage Lab and High-Tension Supply Pole
3.	Spark over characteristics of air insulation subjected to high voltage DC
4.	Measurement of HVDC by sphere gap.
5.	Measurement of break-down voltage by rod gap (HVAC) (uniform and non-uniform field)
6.	Measurement of break-down voltage by rod gap (HVDC) (uniform and non-uniform field)
7.	Measurement of HVAC by sphere gaps
8.	Field mapping using electrolytic tank for any one-model cable/capacitor/transmission line/ Sphere gap models
9.	Measurement of partial discharge using PD set up
10.	Study solid dielectrics used in power apparatus

Course Outcomes: At the end of the course student will be able to

1.	Test the given transformer oil and measure its breakdown voltage & dielectric strength.
2.	Perform suitable test to measure earth resistance of high voltage lab and supply pole
3.	Analyze the concept field mapping using electrolytic tank for the measurement of capacitance for different electrodes
4.	Apply concept of HV technology for the measurement of HVDC and HVAC by sphere gap and rod gap techniques
5.	Demonstrate the measurement of partial discharge using PD set up

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ **Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE3601-1.1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3601-1.2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3601-1.3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3601-1.4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3601-1.5	3	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. M S Naidu & V Kamaraju, “High Voltage Engineering”, 4th Edition, THM, 2008
2. C L Wadhwa, “High Voltage Engineering”, New Age International Private limited, 3rd

	edition, 2010.
3.	E Kuffel & W S Zeengl , "High Voltage Engineering Fundamentals", 2nd edition, Elsevier, press, 2005.

POWER ELECTRONICS LABORATORY

Course Code:	**EE3602-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**0+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EC1001-1, EE2101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the Static characteristics of SCR, MOSFET and IGBT.
2.	To design and test the UJT relaxation oscillator for triggering SCR.
3.	To study AC voltage controller, single -phase controlled rectifier, single-phase inverter, and chopper circuits

Suggested List of Experiments

1.	Static characteristics of SCR
2.	Static characteristics of MOSFET and IGBT.
3.	Gate drive circuit for MOSFET
4.	SCR turn-off using LC commutation
5.	SCR turn-on circuit using synchronized UJT relaxation oscillator
6.	A.C. voltage controller using TRIAC and DIAC combination connected to Load
7.	Single -phase full-wave controlled rectifier
8.	DC step down chopper with R and R-L loads.
9.	DC step up chopper with R and R-L loads.
10.	IGBT-Based Single phase PWM Inverter

Course Outcomes: At the end of the course student will be able to

1.	Draw the static characteristics of MOSFET, IGBT and SCR to identify different regions of operation.
2.	Design and test MOSFET and SCR triggering circuit.
3.	Verify LC commutation circuit to turn-off SCR used in choppers.
4.	Build AC voltage controller using TRAIC-DIAC triggering circuit to produce variable voltage.
5.	Build and test single-phase full-wave and three phase half-wave rectifier to check circuit behavior with R & R-L load.
6.	Verify operation of step up and step-down chopper for R and RL load
7.	Test IGBT based single-phase full-bridge inverter to observe the effect of various modulation techniques.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3602-1.1	3	3	-	-	-	-	-	-	2	2	-	-	1	-
EE3602-1.2	3	3	-	-	-	-	-	-	2	2	-	-	2	-
EE3602-1.3	3	3	-	-	-	-	-	-	2	2	-	-	2	-
EE3602-1.4	3	3	-	-	-	-	-	-	2	2	-	-	2	-
EE3602-1.5	3	3	-	-	-	-	-	-	2	2	-	-	2	-
EE3602-1.6	3	3	-	-	-	-	-	-	2	2	-	-	1	-
EE3602-1.7	3	3	-	-	-	-	-	-	2	2	-	-	1	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:	
1.	M.H.Rashid “Power Electronics”, 3Rd Edition, P.H.I. /Pearson, New Delhi, 2014
2.	Ned Mohan, Tore M. Undeland, and William P. Robins, “Power Electronics – Converters, Applications and Design”, Third Edition, John Wiley and Sons. 2010.

POWER SYSTEM ANALYSIS AND STABILITY LABORATORY

Course Code:	**EE3603-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**0+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE2005-1, EE2001-1, EE2102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To get familiarized with modelling of power systems using PSCAD and MATLAB
2.	To analyze the transient response of RL circuit for sinusoidal input.
3.	To analyze the symmetrical fault in power system
4.	To analyze the unsymmetrical fault in power system
5.	To get familiarized with numerical techniques to solve nonlinear differential equations.

Suggested List of Experiments

1.	Performance analysis of transmission lines using Nominal T and Nominal Pi Methods.
2.	Transient Analysis of RL circuit for sinusoidal input
3.	Analysis of Symmetrical fault on unloaded synchronous generator
4.	Analysis of Symmetrical fault on power system.
5.	Analysis of Symmetrical components from unbalanced phasors for power system
6.	Verification of Phase shift in symmetrical components different winding configurations of Transformer during unsymmetrical fault.
7.	Analysis of unsymmetrical faults in power system with and without fault impedance for i] LG ii]LL and iii] LLG
8.	Transient Analysis of Synchronous machine during fault.
9.	Power angle curve characteristics of salient and non-salient pole machine
10.	Solution of Swing equation using Runge Kutta method

Course Outcomes: At the end of the course student will be able to

1.	Model the interconnected power system and construct the reactance diagram
2.	Analyze symmetrical three phase faults in power system to determine short circuit kVA.
3.	Apply the concept of symmetrical components to calculate sequence components
4.	Analyze Unsymmetrical faults in power system to determine the fault currents
5.	Analyze dynamics of synchronous machine to evaluate transient stability

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3603-1.1	3	3	-	-	3	-	-	-	-	-	-	-	-	2
EE3603-1.2	3	3	-	-	3	-	-	-	-	-	-	-	-	2
EE3603-1.3	3	3	-	-	3	-	-	-	-	-	-	-	-	2
EE3603-1.4	3	3	-	-	3	-	-	-	-	-	-	-	-	2
EE3603-1.5	3	3	-	-	3	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. Nagrath and Kothari: Modern Power System Analysis, 4^{th} edition, MHE 2011
2. John J Grainger, William D Stevenson, Power System Analysis, Tata McGraw-Hill Education

	India, 2014
3.	W.D Stevenson: Elements of Power System Analysis. 4th edition,TMH,2001
4.	Power System Analysis by Arthur Bergen, 2nd edition, Pearson, 1999

Professional Elective Courses (Power Electronics and Drives)

POWER SEMICONDUCTOR DEVICES

Course Code:	**EE2201-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1, EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the principle of operation of power MOSFET and IGBT with their characteristics and effect of reverse recovery transients on switching stresses & losses
2.	To study the construction and switching characteristics of various power semiconductor devices
3.	To illustrate the importance of gate drive circuits for power devices, design of snubber circuits and heat sinks.

UNIT-I

Introduction — **06 Hours**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); selection strategy – On-state and switching losses – EMI due to switching – Power diodes – Types, forward and reverse characteristics, switching characteristics – rating

Power MOSFET — **08 Hours**

Basic structure & operation, I-V Characteristics, On-state operation, Turn-on, turn-off process, Switching characteristics: Turn-on transient, dv/dt capability, Turn-off transient, turn-off time, Switching losses, Safe operating Area, Effect of reverse recovery transients on switching stresses & losses, dv/dt limitations

UNIT-II

Power IGBT — **08 Hours**

Basic structure & operation, i-v characteristics, Latch-up in IGBT, Switching characteristics: turn-on, Turn-off transient, current tailing, Switching losses, Device limits & SOA, Over-current & short-circuit protection of IGBT

Power Electronics Devices — **08 Hours**

Construction and features of - Phase Controlled thyristors, inverter graded thyristors, Wide band gap semiconductors - SiC and GaN Comparison of power devices.

UNIT-III

Firing and Protecting Circuits — **10 Hours**

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit for: SCR, MOSFET, IGBTs SiC and GaN devices. Over voltage, over current and gate protections; Design of snubbers, Guidance for heat sink selection, heat sink types and design – Mounting types.

Course Outcomes: At the end of the course student will be able to

1.	Analyze characteristics of power semiconductor devices to select an appropriate device for given application
2.	Summarize switching and I-V characteristics of MOSFET to know the maximum switching frequency limit
3.	Analyze the I-V and switching characteristics to summarize dv/dt and di/dt limitations, over current and short circuit protections to ensure safe operation of IGBT

4.	Describe the construction and features of the emerging power electronic devices
5.	Analyze the importance of gate drive and protection circuits to switch power electronic converters

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2201-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2201-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE2201-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE2201-1.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2201-1.5	2	2	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Mohan, Undeland and Robins, "Power Electronics – Converters, applications and Design, John Wiley and Sons, Singapore, 2000
2.	Modern Power Electronic Devices: Physics, applications, and reliability, Edited by Francesco Iannuzzo, IET Digital Library
3.	Power Electronics Semiconductor Switches, R.S Ramshaw, Springer; 2nd edition 1993

REFERENCE BOOKS:

1.	Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004
2.	B.W Williams 'Power Electronics Circuit Devices and Applications'. Palgrave publishers,1987.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108105066
2.	https://www.coursera.org/lecture/converter-circuits/sect-4-2-0-introduction-to-power-semiconductors-b5VYY

SWITCHED MODE POWER CONVERTERS			
Course Code:	**EE3201-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concept of switched mode power converters
2.	To study the working of non-isolated and isolated DC-DC switching power converters
3.	To understand the working of switched mode DC-AC inverters
4.	To understand the concept of resonant converter
5.	To study various power line disturbance and power conditioners
6.	To design high frequency transformer and inductor

UNIT-I

DC-DC Converters:	**14 Hours**

Linear voltage regulators (LVRs), a basic switching converter (SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter, inductor current ripple, output voltage ripple, Numerical Problems. Capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, design considerations, boost converter for discontinuous current operation, Principle of operation and analysis of buck-boost converter analysis inductors current ripple and output voltage ripple, design considerations, design problems, buck-boost converter for discontinuous current operation, principle of operation and analysis of CUK converter, inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, design problems Single Ended Primary Inductance Converter (SEPIC) Converter Design consideration, problems

UNIT-II

Magnetics	**04 Hours**

Design of high frequency Inductor and transformers. Design examples for buck, boost, and flyback converter.

Derived Converters:	**08 Hours**

Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations, Numerical problems principle of operation and analysis of forward converter, design considerations, double ended (Two switch) forward converter, principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of half bridge DC-DC converters and full bridge DC-DC converters design considerations,

DC-AC switched mode inverters	**04 Hours**

Basic concept of switch-mode Inverters, single-phase inverter with bipolar and unipolar switching scheme, three phase inverter with unipolar scheme.

UNIT-III

Resonant switch converters	**05 Hours**

Classification of resonant converter, Resonant switch converter – ZCS, ZVS, dc-dc converters with buck converter; Resonant dc-link inverter with ZVS.

Control of DC-DC Converter	**05 Hours**
Modeling of DC-DC converters, Types of converter control mechanism - Voltage mode control, Current mode control, control loop stability, small signal analysis switch transfer function, filter transfer function PWM transfer function, closed loop control of buck and boost converter.	

Course Outcomes: At the end of the course student will be able to

1.	Compare the Linear Voltage Regulator & SMPC and list the advantages of SMPC.
2.	Describe the working principle of various non-isolated dc-dc converters and design the converter for a given specification.
3.	Design magnetic components used in the SMPC and Describe the principle of operation of various isolated dc-dc converter to understand the design steps to be followed & calculate performance parameters.
4.	Describe the principle of operation of DC-AC inverters to calculate performance parameters.
5.	Analyze the performance of different resonant converters to list their advantages in improving the efficiency of SMPC & Model the DC-DC converter to design of compensators

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3201-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3201-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3201-1.3	3	3	-	-	-	-	-	-	-	-	-	1		-
EE3201-1.4	3	3	-	-	-	-	-	-	-	-	-	1		-
EE3201-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High; *- If PBL is carried out as a team

TEXTBOOKS:

1. Ned Mohan, Tore M. Undeland, and William P. Robins, "Power Electronics – Converters, Applications and Design", Third Edition, John Wiley and Sons. 2010.
2. Daniel W Hart, "Power Electronics", Tata McGraw Hill, 2011

REFERENCE BOOKS:

1. L Umanand, "Power Electronics: Essentials & Applications", Wiley, 2009
2. Modern Power Electronics- Cyril Lander,3rd edition, TMH, 2015
3. Christophe P. Basso, "Switch-Mode Power Supplies Spice Simulations and Practical Designs" Revised edition, TMH, 2014
4. L Umanand and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", New Age International, New Delhi, 2009

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/108108036/
2. https://www.coursera.org/learn/electronic-converters
3. https://www.mooc-list.com/course/converter-control-coursera

COMPUTER CONTROL OF ELECTRICAL DRIVES

Course Code:	**EE4201-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Review the applications of microcontrollers and power electronics in industrial drives
2.	Explain the classification and control of AC drive using digital logic
3.	Illustrate the control of synchronous machine and phase controlled converters
4.	Explain the principles of slip power recovery schemes and effect of EMI
5.	Identify the use of expert system application to drives and understand the concept of vector control of ac drives

UNIT-I

Review of Microcontrollers in Industrial Drives System	**04 Hours**
Typical Microcontrollers: 8 bit, 16 bit (only block diagram), Digital Data Acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors	
Evolution of Power Electronics in Drives	**04 Hours**
Power semiconductors devices used for drives control, Ratings, comparison and their applications, Block diagram of power integrated circuit for DC motor drives	
AC Machine Drives	**08 Hours**
General classification and National Electrical Manufacturer Association (NEMA) classification, speed control of Induction motors with variable voltage constant frequency, constant voltage variable frequency, (v/f) constant operation, drive operating regions. Variable stator current operation, Effect of Harmonics	

UNIT-II

Synchronous Machine Drives	**05 Hours**
Wound field machine, comparison of Induction and wound field synchronous machines, Torque angle characteristics of salient pole synchronous machines, synchronous reluctance permanent magnet synchronous machines (SPM), variable reluctance machines (VRM)	
Phase Controlled Converters	**05 Hours**
Converter controls, Linear firing angle control, cosine wave crossing control, phase locked oscillator principle, Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, rectifiers, current fed converters	
Principles of Slip Power Recovery Schemes	**05 Hours**
Static Kramer's drive system, block diagram, phasor diagram and limitations, Static Scherbins scheme system using D.C link converters with cyclo converter modes of operation, modified Scherbins drive for variable source, constant frequency (VSCF) generation	

UNIT-III

Principle of Vector Control of AC Drives	**05 Hours**
Phasor diagram, digital Implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation	
Expert System Application to Drives (Only Block Diagram)	**04 Hours**

Expert system shell, Design methodology, ES based P-I tuning of vector controlled drives system, Fuzzy logic control for speed controller inverter control drives, structure of fuzzy control in feedback system

Course Outcomes: At the end of the course student will be able to

1.	Describe the advances in microcontrollers and power electronics to understand their application in industrial drives
2.	Analyze different speed control methods of AC drives to choose appropriate method for a given drive requirements
3.	Analyze torque angle characteristics of synchronous motor drive, synchronous reluctance and variable reluctance machines, understand phase-controlled converters used in control of electrical drives
4.	Describe the principles of slip power recovery schemes to improve the efficiency of drive
5.	Describe principle of vector control of AC drives and application of expert systems for control of electrical drives

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE4201-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4201-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4201-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4201-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4201-1.5	3	3	-	-	-	-	-	-	-	-	-	2	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Bimal Bose, "Power Electronics & Motor Drives", Elsevier 2006
2. Bimal K. Bose, "Modern Power Electronics & Drives", Pearson Education 2003

REFERENCE BOOKS:

1. Badri Ram "Advanced Microprocessor and Interfacing", TMH,2001
2. BK Bose, "Microcomputer Control of Power Electronics & Drives", IEEE press 1987

POWER ELECTRONICS SYSTEM DESIGN USING ICS

Course Code:	**EE3301-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Analyze power electronic systems using ICs and apply the knowledge in a theoretical context
2.	Understand switching regulator control circuits
3.	Design high performance power electronic circuits using different ICs for various applications
4.	Think laterally and originally to solve power electronic circuits, and evaluate problems for switching power supplies
5.	Analyze Power Plant control using Programmable Logic Controller

UNIT-I

Introduction	**08 Hours**
Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed	
Switching Regulator Control Circuits	**07 Hours**
Introduction, isolation techniques of switching regulator systems, PWM systems	

UNIT-II

Commercial PWM Control ICs and their Application	**08 Hours**
TL 494 PWM Control IC, UC 1840 Programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1852 resonant mode power supply controller	
Switching Power Supply Ancillary, Supervisory & Peripheral Circuits and Components	**08 Hours**
Introduction, Opto-couplers, self-biased techniques used in primary side of reference power supplies, Soft/Start in switching power supplies, current limit circuits, over voltage protection, AC line loss detection, Implementation of different gating circuits	

UNIT-III

Programmable Logic Controllers (PLC)	**09 Hours**
Basic configuration of a PLC, Programming and PLC, program modification, power plant control using PLCs	

Course Outcomes: At the end of the course student will be able to

1.	Describe the techniques used for measurements of parameter in a power electronics circuit
2.	Describe the operation of switching regulator control circuits
3.	Understand the architecture of commercial PWM control ICs
4.	Describe switching power supply ancillary, supervisory & peripheral circuits and components used in designing switching power supply
5.	Apply Programmable Logic Controller in power plant control

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3301-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3301-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3301-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3301-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3301-1.5	3	3	-	-	-	-	-	-	-	-	-	2	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K. Sinha, “Thyristorised Power Controllers”, 2nd Edition, New Age International, 2010
2. Chryssis “High Frequency Switching Power Supplies”, 2ndEdition, MGH, 1989

E Books / MOOCs/ NPTEL

1. https://www.smps.us/smpsdesign.html

SOLID STATE LIGHTING CONTROL

Course Code:	**EE3302-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To acquaint knowledge different types of light source and its utility
2.	To know the integration of lighting in diverse application
3.	To upgrade the knowledge in smart lighting
4.	To enumerate the skill in energy saving using solid state lighting
5.	To give insight to design steps involved in building solid state lighting

UNIT-I

Introduction — **07 Hours**

Different types of light source –black body radiator, human vision, mesopic, scotopic, photopic vision, human light transduction model, lumen, luminous intensity, illumination, luminous efficacy, maintenance factor, depreciation factor, photometric analysis

Color science — **08 Hours**

Introduction to solid state lighting, construction of solid state lighting source, color renderance, correlated color temperature, binning, Macadam ellipse, different steps in Macadam ellipse, chromaticity diagram, color mixing, color evaluation techniques objective and subjective color analysis –problems

UNIT-II

Converters for Lighting — **08 Hours**

Drivers, linear regulator, switch mode regulators using buck, boost and buck boost converter

Light and health — **09 Hours**

Light as radiation, tissue damage by ultraviolet radiation, Tissue Damage by Visible and Near Infrared Radiation, Tissue Damage from Infrared Radiation beyond 1400 nm, Threshold Limit Values, Practical Considerations, Aging Effects, Risk of Exceeding Limits, Using Task Lights, Eyestrain, Migraine, Autism, Visual Comfort and Human Variability, Light Operating through the Circadian System, Sleep, blue light hazard

UNIT-III

Application of Solid-state lighting — **08 Hours**

Horticulture lighting, Hospital lighting, architectural lighting, commercial lighting, Seasonal Affective disorder, Alzheimer, museum lighting

Course Outcomes: At the end of the course student will be able to

1.	Analyze the color discrimination of the light source based on subjective and objective analysis
2.	Identify the LED binning and illustrate the importance of Macadam ellipse
3.	Categorize the color characteristic of the light source
4.	Design the drivers for LEDs based on linear and switch mode regulators
5.	Comprehend the application of solid-state lighting in health, commercial and non-commercial sectors

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3302-1.1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3302-1.2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3302-1.3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3302-1.4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3302-1.5	3	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Fred Schubert, “Light emitting diodes”, 2nd Edition, Rensselaer Polytechnic Institute, New York, Cambridge University Press, 2006.
2. Patrick Mottier, “LED for lighting Applications”, 1st Edition, Wiley, 2009

REFERENCE BOOKS:

1. Sal Cangeloso, “LED lighting a primer to lighting the future ”, Maker press, 2012
2. M Nisa Khan, “Understanding the LED illumination”, CRC Press, 2013

SPECIAL ELECTRICAL MACHINES

Course Code:	**EE3303-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2102-1, EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the working principle of stepper motor and its control
2.	To understand working of switched reluctance motor
3.	To know the difference between PMDC & BLDC motors
4.	To understand principle of operation of permanent magnet synchronous motor
5.	To introduce single phase special machines

UNIT-I

Stepper Motor	**08 Hours**
Variable reluctance (VR) Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types, Windings of Stepper Motor, open –loop, closed loop control of stepper motor, Microprocessor based control of stepper motor	
Switched Reluctance Motor (SRM)	**07 Hours**
Construction, Principle of working, Basic SRM analysis, constraints on pole arc and tooth arc, Power Converter Circuits, Control of SRM, Rotor Position sensors, Current Regulator, Microprocessor Based Control of SRM, Sensorless Control of SRM	

UNIT-II

Synchronous Reluctance Motor (SyRM)	**03 Hours**
Construction, Working, Control of SyRM, Advantage, Applications	
PMDC and BLDC Motors	**09 Hours**
Permanent Magnet DC (PMDC)Motor – Construction, working, Types of PMDC Motors, Brushless Permanent Magnet DC (BLDC) Motors – Classification, construction, Electronic commutation, principle of operation, BLDC square wave motor, Types of BLDC motor, Control of BLDC motor, Microprocessor Based control, DSP Based Control, Sensorless Control, Comparison of DC and BLDC motor, Applications	
Permanent Magnet Synchronous Motor	**03 Hours**
Construction, principle of operation, Control of PMSM, Applications of PMSM	

UNIT-III

Single Phase Special Electrical Machines	**05 Hours**
AC Series Motor – Construction, Working Principle, torque-speed characteristics. Repulsive Motor – Construction, types. Hysteresis Motor, Single Phase Reluctance Motor, Universal Motor – Types, Construction, principle of operation, speed control	
Servo Motors	**05 Hours**
DC Servo Motors – Construction, Principle of operation, voltage equation, control of DC servo motor. AC Servo Motor – Construction, working, torque speed characteristics	

Course Outcomes: At the end of the course student will be able to

1.	Describe working principle of different stepper motor types to achieve microprocessor based control
2.	Summarize working principle and requirements of power converter to achieve sensorless control of switched reluctance motor
3.	Compare and differentiate PMDC & BLDC motors to select a drive based on requirements
4.	Describe the principle of operation of permanent magnet synchronous motor
5.	Outline the operation of single phase special machines and servo motors

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3303-1.1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3303-1.2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3303-1.3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3303-1.4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3303-1.5	3	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	E. G Janardanan, 'Special Electrical Machines' PHI Delhi, 2014

REFERENCE BOOKS:

1.	T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Claredon press, London, 1989
2.	R.Krishnan, ' Switched Reluctance motor drives' , CRC press, 2001
3.	T.Kenjo, ' Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000

ELECTRICAL MACHINE DESIGN

Course Code:	**EE3304-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2001-1, EE2102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To describe the process of electrical machine design
2.	To illustrate the design of single phase and three phase transformer
3.	To analyze the design of DC machines and Synchronous Machines
4.	To the analyze the design of Three phase Induction Machine

UNIT-I

Principles of electrical machine design	**02 Hours**

Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines.

Design of Transformers (Single Phase and Three Phase)	**09 Hours**

Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and cross sectional area of Primary and secondary windings, estimation of no load current, Design of tank and cooling tubes (round and rectangular).

Design of Induction Motors	**04 Hours**

Output equation, Choice of specific loadings, main dimensions of three phase induction motor.

UNIT-II

Design of Induction Motors (Contd.)	**08 Hours**

Stator winding design, choice of length of the air gap. Estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring Rotor

Design of DC Machines	**07 Hours**

Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles, field windings – shunt, series and inter poles.

UNIT-III

Design of Synchronous Machines	**10 Hours**

Output equation, Choice of specific loadings, short circuit ratio, design of main dimensions, armature slots and windings, slot details for the stator of salient and non - salient pole synchronous machines, design of rotor of salient pole machines, magnetic circuits, dimensions of the pole body, design of the field winding, and design of rotor of non-salient pole machine.

Course Outcomes: At the end of the course student will be able to

1.	Describe the design process of electrical machines for given specification
2.	Design single phase and three phase transformers for specified specifications
3.	Design the stator and rotor of the induction machine for the given specifications

4.	Design the armature and field system of a DC machine for given specifications
5.	Design the stator and rotor of the synchronous machine for the given specifications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3304-1.1	3	3	2	-	-	-	-	-	-	-	-	-	-	-
EE3304-1.2	3	3	3	-	-	-	-	-	-	-	-	-	-	-
EE3304-1.3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
EE3304-1.4	3	3	3	-	-	-	-	-	-	-	-	-	-	-
EE3304-1.5	3	3	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. A.K.Sawhney , "A Course in Electrical Machine Design", Dhanpatt Rai& Sons,7TH EDITION, 2003.
2. V. N. Mittle, "Design of Electrical Machines", Standard Publishers distributors ,4th edition,2009.

REFERENCE BOOKS:

1. A. Shanmugasundarm, G. Gangadharan, R.Palani, "Design Data Handbook", Wiley Eastern Lt.

Professional Elective Courses (Control Systems Stream)

ROBOTICS AND AUTOMATION

Course Code:	**EE2211-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2002-1, MA2008-1, EE3002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the basic composition of a robot
2.	To illustrate various robot sensors and construction of robot
3.	To familiarize the concept of kinematics of the robot
4.	To enumerate the functions and advantages of the robot
5.	To know the robot programming concept

UNIT-I

Introduction	**08 Hours**

Introduction to robotics, Components and Structure of Robots, robot classification, robot configurations, specifications, Common Kinematic arrangements, Rotations, Composition of Rotations, Properties, rigid motion, and Homogeneous Transformation, representing position and rotation, rotational transformations, composition of rotations, parameterization of rotation

Robot sensors	**04 Hours**

Introduction, desirable features of sensors, magnetic sensors, fibre optic, tactile sensors, proximity and non-proximity sensors

Manipulators, Actuators and grippers	**04 Hours**

Construction of manipulators, types of actuators, grippers, classification, force analysis of gripper mechanism, designing of grippers

UNIT-II

Control	**04 Hours**

Introduction, Actuator dynamics, Set-Point Tracking, Drive Train Dynamics, Trajectory Interpolation, Feed forward Control and Computed Torque

Kinematics	**04 Hours**

Forward, inverse and velocity kinematics Denavit- Hardenberg Representation, Examples

Dynamics	**06 Hours**

Euler Lagrange Equations, Expressions for kinetic and potential energy, Equation of Motions, Common configuration, Newton Euler Formulation, Robot machine vision: Introduction, image processing and analysis

UNIT-III

Robot programming	**05 Hours**

Lead through programming methods, Robot programming languages-examples

Case studies	**05 Hours**

Robot applications in manufacturing, robot cell design, machine interface, multiple robots, robot in assembly and inspection

Course Outcomes: At the end of the course student will be able to

1.	Recognize the components and classify robots based on its composition
2.	Identify and describe various sensors to construct the robot
3.	Derive the kinematics of the robot to derive the control aspects

4.	Apply the mathematical models to validate the dynamics of the system
5.	Identify different programming methods and languages to the effective functioning of robot.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2211-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2211-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2211-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2211-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2211-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Mark W.Spong & M.Vidyasagar. Robot Dynamics and Control, Willey India Publisher, 2009.
2. Mikell P.G, Weiss M.Nagel R.N Odrey N.G, Industrial robotics, McGraw Hill Education India Private Limited; 2 edition (23 May 2012)

REFERENCE BOOKS:

1. Lee, K.S. Fu, R.C. Gonzalez & C.S.G, Robotics, McGraw Hill,2008
2. Bruno Sicilian, Modelling and controlling of Robot manipulations, Springer,2000
3. Saeed B. Niku, Introduction to robotics, PHI,2005
4. Robert J. Schilling, Fundamentals of Robotics Analysis and control, PHI,1996

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/112107289
2. https://nptel.ac.in/courses/112101099

PHYSIOLOGY CONTROL SYSTEM MODELLING AND SIMULATION

Course Code:	**EE3211-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**BT1651-1, MA1003-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the basic system concepts and differences between an engineering and physiological control systems
2.	To acquaint students with different mathematical techniques applied in analysing a system and the various types of nonlinear modelling approaches.
3.	To teach neuronal membrane dynamics and to understand the procedures for testing, validation, and interpretation of physiological models.
4.	To study the cardiovascular model and apply the modelling methods to multi-input and multi output systems

UNIT-I

Introduction to Physiological control systems	**07 Hours**
Introduction, Similarities and difference with Technological control, Transfer of substances between physiological compartments: By diffusion, by fluid flow and separated by a thin membrane using differential equations	
Regulation in physiological control system	**08 Hours**
Regulation of electrolyte concentration, acid base balance, red blood cell production, arterial pressure, blood volume, respiration, body temperature, blood glucose	

UNIT-II

Biological control structure and modelling	**08 Hours**
Basic control structure and detailed parameters, Biofeedback, modelling of human thermal regulatory system including control aspects, Biochemistry of digestion, types of heat loss from body	
Control and regulation of respiratory system	**07 Hours**
Modelling of oxygen uptake, mass balance of lungs, gas transport mechanism of lungs, oxygen and carbon dioxide transport in blood and tissue	

UNIT-III

Application of biological control	**05 Hours**
Eye tracking control, Pupil control	
MATLAB Application and simulation	**05 Hours**
Derivation of Cardiovascular control system theoretical and using MATLAB	

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the basic system concepts and differences between an engineering and physiological control systems
2.	Understand the application of various mathematical techniques in designing a bio-control system
3.	Comprehend the techniques of plotting the responses in both the domain analysis
4.	Apply time domain and frequency domain analysis to study the biological system
5.	Develop simple models of the physiological control systems and analyze its stability

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3211-1.1	3	3	-	2	1	1	-	-	-	-	-	-	-	-
EE3211-1.2	2	2	2	2	-	-	-	-	-	-	-	-	-	-
EE3211-1.3	3	2	2	1	2	1	-	-	-	-	-	-	-	-
EE3211-1.4	2	3	-	-	1	-	-	-	-	-	1	-	-	-
EE3211-1.5	3	3	-	2	2	-	-	-	-	-	2	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. David. Cooney, "Bio- Medical Engineering Principles", Michel Deckker, INC.
2. John H Milsum "Biological control systems", McGraw Hill 1966.
3. Howard T Milhorn, "The Application of Control Theory of a Physiological System", McGraw Hill 1966
4. Benjamin C Kuo. Automatic control systems", McGraw Hill India
5. I. J .Nagarath.& M. Gopal, "Control system Engineering", New Age. International Publishers, 2007.

REFERENCE BOOKS:

1. Joseph DiStefano, "Dynamic Systems Biology Modeling and Simulation", 2015, 1st Edition, Academic Press, Massachusetts.
2. Robert Rushmer, "Medical Engineering –Projections" for Health Care Delivery, 2012, 1st Edition, Academic Press, Massachusetts
3. David Cooney, "Bio-Medical Engineering Principles", 2015, 1st Edition, Marcel Deckker Pub Co., New York

E Books / MOOCs/ NPTEL

1. https://www.wiley.com/enus/Physiological+Control+Systems%3A+Analysis%2C+Simulation%2C+and+Estimation%2C+2nd+Edition-p-9781119058809

ADVANCED CONTROL SYSTEMS

Course Code:	**EE4211-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3002-1, MA2004-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To outline the state model and deduce the state equations for LTI systems.
2.	To compute state transition matrix, the Eigen values and Eigen vectors.
3.	To analyze the system for controllability and observability.
4.	To design the controller using pole placement techniques to ensure stability.
5.	To understand the behavior of non-linear system and analyse the phase trajectory
6.	To study the Lyapunov stability criteria for nonlinear systems.

UNIT-I

Introduction — **07 Hours**

State variable analysis & design, canonical representation and transfer function, linearization of state equations, State space representation using physical variables. State space representation using phase variables & canonical variables, Derivation of transfer function from state model, Solution of state equation.

Computation of State transition Matrix — **07 Hours**

State transition matrix & its properties, computation using Laplace transformation, Cayley Hamilton method (only computation), Eigenvalues, Eigen vectors, generalized Eigen vectors, diagonalization of state matrix

UNIT-II

Controllability & Observability — **08 Hours**

Concept of controllability & observability, alman's test and Gilbertz test. Pole placement techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement.

Non-linear system — **08 Hours**

Introduction, behaviour of non-linear system, common physical non-linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity, Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories by Isocline method

UNIT-III

10 Hours

Lyapunov 's stability criteria for linear as well as nonlinear systems, stability definitions, theorems, sign definiteness, direct method, second method, Krasovskii's method, variable gradient method.

Course Outcomes: At the end of the course student will be able to

1.	Develop various state space model to obtain the transfer function for LTI system
2.	Compute state transition matrix to solve the state equation
3.	Analyze the pole placement techniques to enhance the stability of the system.
4.	Identify the behavior of nonlinear system & evaluate various methods of stability to

	understand the system behavior.
5.	Apply Lyapunov criteria to evaluate the Stability of linear and nonlinear system

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE4211-1.1	3	3	1	-	-	-	-	-	-	-	-	1	-	-
EE4211-1.2	3	3	1	-	-	-	-	-	-	-	-	1	-	-
EE4211-1.3	3	3	1	-	-	-	-	-	-	-	-	1	-	-
EE4211-1.4	3	3	1	-	-	-	-	-	-	-	-	1	-	-
EE4211-1.5	3	3	1	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Nagarath and M.Gopal, "Control Systems Engineering", New Age International (P) Limited, Publishers, 5th edition – 2007
2.	M. Gopal "Digital control & state variable methods" 4th edition, Tata. Mc Graw Hill 2012.
3.	M. N. Bandyopadhyay, "Control Engineering: Theory and Practice", PHI Learning Pvt. Ltd. 2002

REFERENCE BOOKS:

1.	Katsuhiko Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc,1967.
2.	Benjamin C. Kuo & Farid Golnaraghi, "Automatic Control Systems" 9th edition, John Wiley & Sons 2009.
3.	Katsuhika Ogata, " Modern Control Engineering" PHI ,6th edition,2010.

E RESOURCES:

1.	http://nptel.ac.in/courses/108103007/
2.	https://www.coursera.org/learn/designing-organization/lecture/Md2km/4-2-2-traditional-control-systems
3.	https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x

DISCRETE CONTROL SYSTEMS

Course Code:	**EE4212-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To model the discrete-time systems by pulse transfer function
2.	To study the stability of discrete time systems and the time response of discrete systems
3.	To examine the response of discrete time systems and the controllability, observability and stability of discrete state space model
4.	To introduce the concept of state feedback system and the digital control systems with deadbeat response
5.	To analyze the sampled data control systems using root locus and bode plot techniques

UNIT-I

Introduction to digital control — **08 Hours**

Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction, Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction

Stability analysis and Time response of discrete time systems — **08 Hours**

Jury stability test, Stability analysis using bi-linear transformation, Transient and steady state responses, Time response parameters of a prototype second order system.

UNIT-II

Discrete state space model — **04 Hours**

Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation

Controllability, observability and stability of discrete state space models — **04 Hours**

Controllability and observability, Stability, Lyapunov stability theorem

State feedback design — **07 Hours**

Pole placement by state feedback, Set point tracking controller, Full order observer, Reduced order observer, Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response

UNIT-III

Illustration of design procedures of sampled data control systems — **09 Hours**

Root locus method, Nyquist stability criteria, Bode plot, Controller design using root locus, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag-lead compensator design in frequency domain (qualitative)

Course Outcomes: At the end of the course student will be able to

1.	Develop the mathematical modelling of the discrete-time systems to derive the pulse transfer function
2.	Analyse the stability & times response characteristics of discrete time systems to observe the system performance.
3.	Develop various state space model & construct state matrix to solve the state equation
4.	Design the various state feedback system & identify the issues of deadbeat response design

	to digital control system
5.	Analyse discrete time controllers using root locus and bode plot techniques to evaluate the system stability

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE4212-1.1	2	2	3	-	-	-	-	-	-	-	-	-	-	3
EE4212-1.2	2	2	3	-	-	-	-	-	-	-	-	1	-	2
EE4212-1.3	2	2	3	-	-	-	-	-	-	-	-	-	-	2
EE4212-1.4	2	2	3	-	-	-	-	-	-	-	-	1	-	-
EE4212-1.5	2	2	3	-	-	-	-	-	-	-	-	1	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. K. Ogata, "Discrete Time Control Systems", Pearson Education, 2/e, 2015.
2. M. Gopal, "Digital Control and State Variable Methods", Tata Mcgraw Hill, 2/e, 2003.

REFERENCE BOOKS:

1. B. C. Kuo, "Digital Control Systems", Oxford University Press-New Delhi, 2/e, Indian Edition, 2012.
2. K.Ogata, "Discrete time control system", Prentice Hall India Learning Private Limited
3. G. F. Franklin, J. D.Powell and M. L. Workman, "Digital Control of Dynamic Systems", Pearson Education 3rd Edition, 2005
4. K. J. Astroms and B. Wittenmark, "Computer Controlled Systems - Theory and Design", Prentice Hall, 3/e, 1997.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108103008

PROGRAMMABLE LOGIC CONTROLLERS

Course Code:	**EE2311-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1002-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the role of PLC in automation and SCADA, hardware capabilities of PLC in industrial automation.
2.	To Program a PLC using ladder Diagram, Functional Block Diagram (FBD), Sequential Functions Charts (SFC), Instruction List (IL) and Structured Text (ST) methods
3.	To Program a PLC using timers, counters, shift registers, data handling instructions

UNIT-I

Introduction	**08 Hours**

Introduction to Programmable logic controller (PLC), SCADA Fundamentals, Building blocks of SCADA systems, role in automation, advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs I/O addresses, Human Machine Interfaces (HMIs)

Ladder and Functional Block programming	**06 Hours**

Ladder diagrams, logic functions, latching, multiple outputs, entering ladder programs, functional blocks, program examples, Location of stop and emergency switches

UNIT-II

IL, SFC, and ST Programming Methods	**04 Hours**

Instruction list, sequential functions charts, structured text programming

Internal Relays	**06 Hours**

ladder programs, battery- backed relays, one - shot operation, set and reset, master control relay, example programs, jump and call subroutines

Timers	**06 Hours**

Types of timers, programming timers, On delay timers, OFF- delay timers, pulse timers, cascading timers, programming examples

UNIT-III

Counters	**04 Hours**

Forms of counter, programming counters, up and down counting, timers with counters, sequencer

Shift register and data handling	**06 Hours**

Shift registers, ladder programs, registers and bits, data handling, arithmetic functions, closed loop control, Structure of control system, Temperature control

Course Outcomes: At the end of the course student will be able to

1.	List and describe characteristics of various I/O devices and interface them to PLC unit
2.	Apply suitable logic using ladder and functional block programming languages to achieve specific control mechanism for a given application
3.	Use internal relays and other programming languages of PLC to control peripheral devices

4.	Identify timer resources of a PLC to design control logic for interfaced device
5.	Choose counters and special functionalities of PLC to control and monitor functions and design the real-world applications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE2311-1.1	3	-	-	-	-	1	-	-	-	-	-	-	-	-
EE2311-1.2	1	3	-	-	1	-	-	-	-	-	-	-	-	3
EE2311-1.3	1	2	3	-	1	-	-	-	-	-	-	1	-	1
EE2311-1.4	1	2	3	-	1	-	-	-	-	-	-	2	-	2
EE2311-1.5	1	2	3	-	1	2	-	-	-	-	-	2	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1. W Bolton "Programmable Logic controllers", 6th edition, Elsevier- newness, 2015.
2. John W Webb, Ronald A Reis, "Programmable logic controllers - principles and applications" -5th edition, 2nd impression, Pearson education, 2009

REFERENCE BOOKS:

1. John W Webb, Ronald A Reis, "Programmable Controller Theory and Implementations", -2nd edition, 2003..
2. E. A Paar, "Programmable Controllers – An Engineers Guide" 3rd edition, newness, 2003.

E Books / MOOCs/ NPTEL

1. https://www.coursera.org/learn/intelligent-machining/lecture/fGz3r/programmable-logic-controllers-plc
2. https://nptel.ac.in/courses/112102011
3. http://nptel.ac.in/courses/112103174/

MICRO AND NANO SCALE SENSORS AND TRANSDUCERS

Course Code:	**EE2312-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To explain measurement of pressure using sensors based on nanotechnology, their structure, theory of operation
2.	To explain structure, theory of operation of sensors based on nanotechnology for Motion, acceleration, measurement, gas and smoke detection
3.	To explain sensors based on nanotechnology for the measurement of atmospheric moisture and moisture inside the electronic components
4.	To explain Optoelectronic and Photonic Sensors used in optical microphones, fingerprint readers, and highly sensitive seismic sensors
5.	To explain the structure, operation of Biological Sensors, Chemical Sensors, used in multipurpose biological and chemical analysis devices and Electric, Magnetic, and RF/Microwave, Integrated Sensor/Actuator Units and Special Purpose Sensors driven by nanotechnology

UNIT-I

Pressure, Motion and Acceleration Sensors	**10 Hours**
Capacitive Pressure Sensors, Inductive Pressure Sensors, Ultrahigh Sensitivity Pressure Sensors, Ultrahigh Sensitivity, Wide Dynamic Range Sensors, Other Motion and Acceleration Micro sensors	
Gas and Smoke Sensors	**04 Hours**
A CO Gas Sensor Based on Nanotechnology, Smoke Detectors	

UNIT-II

Moisture, Optoelectronic and Photonic Sensors	**08 Hours**
Structure, Theory, Main Experimental Results, Auxiliary Experimental Results, Optoelectronic Microphone, Other Optoelectronic and Photonic Micro Sensors	
Biological, Chemical, and "Lab on a Chip" Sensors	**04 Hours**
Lab on a Chip Sensors, Other Biochemical Micro- and Nano-Sensors	
Electric, Magnetic, and RF/Microwave Sensors	**04 Hours**
Magnetic Field Sensors, Other Important Electromagnetic/RF Micro- and Nano-Sensors	

UNIT-III

Integrated Sensor/Actuator Units and Special Purpose Sensors	**10 Hours**
Aircraft Icing Detectors: Introduction and Principle of Operation, theory, Microfluidic, Micro-Actuators, Other Special Purpose Small-Scale Devices	

Course Outcomes: At the end of the course student will be able to

1.	Classify various pressure sensors, and select a sensor depending upon the application
2.	Categorize various motion & acceleration sensors, gas and smoke sensors and choose a sensor for a particular application
3.	Classify various moisture sensors, Optoelectronic & Photonic Sensors and select a sensor

	depending upon the application
4.	Categorize various Biological, Chemical, and "Lab on a Chip" Sensors, Electric, Magnetic, and RF/Microwave Sensors and choose a sensor for a particular application
5.	Classify various Integrated Sensor/Actuator Units and Special Purpose Sensors and select a sensor depending upon the application

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2312-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2312-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2312-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2312-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2312-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Ezzat G. Bakhoum, "Micro- and Nano-Scale Sensors and Transducers", CRC Press, 2015

REFERENCE BOOKS:

1. M. J. Usher & D. A. Keating, "Sensors and Transducers: Characteristics, Applications, Instrumentation, Interfacing".

ADVANCED INSTRUMENTATION SYSTEMS

Course Code:	**EE3311-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2, EE2002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To know the various aspects of instrumentation
2.	To understand the working principles of various measuring instruments and their characteristics
3.	To comprehend with the working of various transducers
4.	To know the need of Data acquisition, conversion and transmission

UNIT-I	
Instrumentation	**07 Hours**
Frequency meter, measurement of time and frequency (mains), tachometer, phase meter, capacitance meter, Automation in digital Instrumentation	
Analyzer	**08 Hours**
Wave analyzers and Harmonic distortion, Basic wave analyzer, Frequency selective wave analyzer, Harmonic distortion analyzer and Spectrum analyzer	
UNIT-II	
Measuring Instruments	**04 Hours**
Output power meters, Field strength meter Vector impedance meter, Q meter applications-Z, Z0 and Q, Basic LCR bridge, RX meters	
Measurement of power	**04 Hours**
Measurement of large amount of RF power (calorimetric method), measurement of power on a transmission line, standing wave ratio measurements	
Transducers	**08 Hours**
Synchro's, Capacitance Transducers, Load cells, Piezo electrical Transducers, IC type temperature sensors, Pyrometers, Ultrasonic temperature Transducer, Reluctance pulse pick-ups, Flow measurement-mechanical Transducers; Magnetic flow meters, turbine flow meters. β-gauge	
UNIT-III	
Data acquisition and conversion	**05 Hours**
Generalized data acquisition system (DAS), Signal conditioning of inputs, single channel DAS, multi-channel DAS, data loggers, compact data logger.	
Data transmission	**04 Hours**
Universal serial bus, IEEE-1394, Long distance data transmission (modems), IEEE 488 bus, Electrical interface	

Course Outcomes: At the end of the course student will be able to

1.	Describe the principle of different sensors for the measurement of frequency and phase
2.	List various types of signal analyzer to understand the operating principle & applications
3.	Describe the operating principle of various measuring instruments to determine the electrical parameters
4.	Describe the working principles of various transducers to measure the electrical parameters of physical system
5.	Describe the process of data acquisition and conversion for the effective data transmission

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE3311-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3311-1.2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
EE3311-1.3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
EE3311-1.4	3	-	-	-	-	-	-	-	-	-	-	1	-	-
EE3311-1.5	3	-	-	-	-	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. "Electronic Instrumentation", MHE, 3rd Edition, 2010

REFERENCE BOOKS:

1. Cooper D and A D Helfrick, "Modern Electronic Instrumentation and Measuring Techniques", PHI,2009
2. Stanley Wolf, Richard F H, Smith, "Student Reference Manual for Electronic Instrumentation Laboratories", PHI, 2nd Edition, 2010

INDUSTRIAL SERVO CONTROL SYSTEMS

Course Code:	**EE3312-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
2.	To discuss system analogs and vectors, with a review of differential equations
3.	To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams
4.	To determine the frequency response techniques for proper servo compensation
5.	To explain perform indices and performance criteria for servo systems

UNIT-I

Introduction	**08 Hours**

Benefits of Servo Systems, Types of Servos - Evolution of Servo Drives, Classification of Drives, Components of Servos - Hydraulic/Electric Circuit Equations, Actuators—Electric, Actuators—Hydraulic, Amplifiers—Electric, Amplifiers—Hydraulic, Transducers (Feedback)

Drives	**04 Hours**

Machine Servo Drives: Types of Drives, Feed Drive Performance, Troubleshooting Techniques: Techniques by Drive, Problems: Their Causes and Cures, Machine Feed Drives: Advances in Technology, Parameters for making Application Choices

Application of Industrial Servo Drives	**04 Hours**

Introduction, Physical System Analogs, Quantities and Vectors, Differential Equations for Physical Systems, Electric Servo Motor Transfer Functions and Time Constants, Transport Lag Transfer Function, Hydraulic Servo Motor Characteristics, General Transfer Characteristics

UNIT-II

Generalized Control Theory	**08 Hours**

Servo Block Diagrams, Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts, Nichols Charts, Servo Analysis Techniques, Servo Compensation.
Indexes of Performance: Definition of Indexes of Performance for Servo Drives, Indexes of Performance Electric and Hydraulic Drives

Performance Criteria	**07 Hours**

Percent Regulation, Servo System Responses.
Servo Plant Compensation Techniques: Dead-Zone Non-linearity, Change-in-Gain Non-linearity, Structural Resonances, Frequency Selective Feedback, Feed-forward Control.
Machine Considerations: Machine feed drive Considerations, Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives

UNIT-III

Machine Considerations	**09 Hours**

Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque and Friction Considerations, Drive Duty Cycles

Course Outcomes: At the end of the course student will be able to

1.	Identify the benefits of servo system and various components to use in hydraulic /electric circuits
2.	Derive differential equations & transfer functions of servo system to apply in physical systems
3.	Apply the generalized control theory for servo systems to study the frequency response
4.	Describe the various performance criteria & servo plant compensation techniques to the servo system
5.	Identify the various machine considerations for servo drive systems

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE3312-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3312-1.2	1	3	-	-	-	-	-	-	-	-	-	-	-	2
EE3312-1.3	1	2	3	-	-	-	-	-	-	-	-	-	-	2
EE3312-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3312-1.5	1	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. George W. Younkin, "Industrial Servo Control Systems Fundamentals and Applications", Marcel Dekker, 1st Edition, 2003

REFERENCE BOOKS:

1. Riazollah Firoozian, "Servo Motors and Industrial Control Theory", Springer, 2nd Edition, 2014
2. Stephen M. Tobin, "DC Servos Application and Design with MATLAB", CRC, 1st Edition, 2011

Professional Elective Courses (Energy System Stream)

DEMAND SIDE MANAGEMENT

Course Code:	**EE2221-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2104-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To determine the demand, profile of usage and techniques of energy measurement
2.	To understand the power distribution for economic development of the nation.
3.	To understand the parameters of electrical system optimization
4.	To introduce and analyze various techniques of demand side management.
5.	To be familiarized with load management & different electrical tariff systems

UNIT-I

Introduction:	**05 Hours**
Energy situation – world and India, energy consumption, conservation. codes, standards and legislation	
Energy Economic Analysis:	**05 Hours**
The time value of money concept, developing cash flow models, Payback analysis, depreciation, taxes and tax credit –problems.	
Energy Auditing:	**05 Hours**
Introduction, elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results	

UNIT-II

Electrical System Optimization:	**05 Hours**
The power triangle, motor horsepower, power flow concept, electrical equipment and power factor –correction & location of capacitors.	
Demand Side Management:	**10 Hours**
Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model and time of day models for planning.	

UNIT-III

Energy efficient motors, Lighting basics, Electrical rate tariff:	**10 Hours**
Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.	

Course Outcomes: At the end of the course student will be able to

1.	Estimate energy consumption & conservation by suggesting installation modification to compute payback period.
2.	Measure and collect data to present energy audit results.
3.	Analyze the power flow based on motor horsepower to suggest power factor correction.
4.	Describe various techniques to implement demand side management.
5.	Evaluate various methods to manage the load using energy efficient equipment.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2221-1.1	2	3	-	-	-	-	1	-	-	-	-	-	-	-
EE2221-1.2	2	3	-	-	-	1	1	-	-	-	-	-	-	-
EE2221-1.3	2	3	-	-	-	-	1	-	-	-	-	-	-	-
EE2221-1.4	2	3	-	-	-	-	1	-	-	-	-	-	-	-
EE2206-1.5	2	3	-	-	-	1	1	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Larry C. White, Philip S. Schmidt, David R. Brown, "Industrial Energy Management Systems", Hemisphere Publishing Corporation, New York.
2. Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall Inc, Englewood Cliffs, New Jersey
3. Sonal Desai , "Handbook of Energy Audit", McGraw Hill Education (India) Private Limited, 2015

REFERENCE BOOKS:

1. Jyothi Prakash, "Demand Side Management", TMH Publishers.
2. Hand book on energy auditing - TERI (Tata Energy Research Institute)

RENEWABLE ENERGY SOURCES

Course Code:	**EE2222-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2104-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the principle of extraction of energy from conventional and non- conventional sources
2.	To familiarize with the operation and applications of solar based thermal, electrical and PV systems
3.	To justify the usage of energy storage techniques
4.	To discuss the design process and implementation of wind based energy conversion systems
5.	To study the process of design and implementation of biomass based energy conversion systems

UNIT-I

Energy Sources	**03 Hours**

Introduction, importance of energy consumption as measure of prosperity, Per capita energy consumption, classification of energy resources; conventional energy resources - availability and their limitations; non-conventional energy resources – classification, advantages, limitations; comparison of conventional and non-conventional energy resources; world energy scenario; Indian energy scenario

Solar Energy Systems	**13 Hours**

Introduction, solar constant, basic sun-earth angles – definitions and their representation, solar radiation geometry (numerical problems), estimation of solar radiation of horizontal and tilted surfaces (numerical problems); measurement of solar radiation data – Pyranometer and Pyrheliometer.

Solar Thermal Systems: Principle of conversion of solar radiation into heat, solar water heaters (flat plate collectors), solar cookers – box type, concentrating dish type, solar driers, solar still, solar furnaces and solar green house.

Solar Electric Systems: Solar thermal electric power generation – solar pond and concentrating solar collector (parabolic trough, parabolic dish, central tower collector). Advantages and disadvantages; solar photovoltaic – solar cell fundamentals, characteristics, classification, construction of module, panel and array.

Solar PV Systems – stand-alone and grid connected systems; its applications to street lighting, domestic lighting and solar water pumping systems

UNIT-II

Energy Storage	**04 Hours**

Introduction, necessity of energy storage, and methods of energy storage (classification and brief description using block diagram representation only)

Wind Energy	**04 Hours**

Introduction, wind and its properties, history of wind energy, wind energy scenario – world and India. Basic principles of wind energy conversion systems (WECS), classification of WECS, parts of a WECS, derivation for power in the wind, electrical power output and capacity factor of WECS, wind site selection consideration, advantages and disadvantages of WECS

Biomass Energy	**07 Hours**

Introduction, photosynthesis process, biomass fuels, biomass conversion technologies, urban waste to energy conversion, biomass gasification, biomass to ethanol production, biogas production from waste biomass, factors affecting biogas generation, types of biogas plants – KVIC and Janata model; biomass program in India

UNIT-III

Energy from Ocean	**06 Hours**

Tidal energy – Principle of tidal power, components of tidal power plant (TPP), classification of tidal power plants, estimation of energy – single basin and double basin type TPP (no derivations. simple numerical problems), advantages and limitation of TPP.
Ocean thermal energy conversion (OTEC): principle of OTEC system, methods of OTEC power generation – open cycle (Claude cycle), closed cycle (Anderson cycle) and hybrid cycle (block diagram description of OTEC); site-selection criteria, bio fouling, advantages & limitation of OTEC

Emerging Technologies	**03 Hours**

Fuel cell, small hydro resources, hydrogen energy and wave energy. (Principle of energy generation using diagrams, advantages and limitations).

Course Outcomes: At the end of the course student will be able to

1.	Describe nonconventional energy sources and solar radiation geometry to estimate & measure solar radiation
2.	Apply the principle of solar radiation into heat to understand the operation of solar thermal and solar electric systems
3.	Describe energy storage methods and wind-energy conversion systems to understand the factors influencing power generation
4.	Apply the biomass conversion technologies to design biomass based energy systems.
5.	Describe tidal, ocean thermal and fuel cell energy conversion systems to understand emerging renewable energy technologies

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2222-1.1	3	-	-	-	-	-	-	-	3	-	-	-	-	-
EE2222-1.2	2	3	-	-	-	2	2	2	2	3	-	-	-	1
EE2222-1.3	3	-	-	-	-	2	2	-	3	-	-	-	-	1
EE2222-1.4	2	3	-	-	-	2	1	-	2	3	-	-	-	-
EE2222-1.5	3	-	-	-	-	2	2	-	3	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Rai G. D., "Non-Conventional Sources of Energy", 5th Edition, Khanna Publishers, New Delhi, 2014
2. Khan, B. H., "Non-Conventional Energy Resources", TMH, New Delhi, 2^{nd} Edition, 2009.

REFERENCE BOOKS:

1. Mukherjee D. and Chakrabarti, S., "Fundamentals of Renewable Energy Systems", New Age International Publishers, **5^{th} edition,** 2011.
2. S. P. Sukhatme, J. K. Nayak "Solar Energy: Principles of Thermal Collection and Storage", 3e McGraw-Hill Education (India) (2009).

ELECTRICAL CIRCUITS AND POWER DISTRIBUTION			
Course Code:	**EE2223-1**	**Course Type:**	**PEC**
Teaching Hours/Week (L: T: P):	**3:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To familiarize the student with the DC circuit analyses.
2.	To analyze single and three-phase AC circuits.
3.	To understand the working principle of electrical machines.

UNIT-I

Circuit Fundamentals	**05 Hours**
Basic nodal and mesh analysis excited by independent DC voltage sources, Power, and Energy. Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities. Star delta transformations.	
A.C. Circuits	**11 Hours**
Single Phase AC Circuits: Analysis of R, L, C, R-L, R-C and R-L-C series and parallel circuits for sinusoidal excitation. Phasor Diagrams. Real power, reactive power, apparent power, and power factor. Resonance: Series and parallel resonance, concept of band width and Q factor. **Three phase AC circuits:** Three-phase balanced circuits, voltage and current relations in star and delta connections. Measurement of three phase power using two wattmeters. three phase four wire circuits.	

UNIT-II

DC motors	**06 Hours**
Constructional details, Principle of operation of motor, Expression for back emf, Types of dc motors, Characteristic of dc motors (shunt and series motors only) and Applications.	
Single-Phase Transformers	**09 Hours**
Faradays Laws, self and mutually induced emfs. Necessity of transformer, Principle of operation. Types of Transformers, Emf equation, phasor diagrams at no load and full load, equivalent circuit, losses, efficiency, problems on emf equation and efficiency, Autotransformer, Applications.	

UNIT-III

Three Phase Synchronous Machines	**04 Hours**
Basic parts, Principle of operation, Synchronous speed, Frequency of generated voltage, Emf equation. Concept of winding factor .Principle of operation of Synchronous Motor. Applications	
Induction Motors	**05 Hours**
Concept of rotating magnetic field, Construction and working of a three-phase Induction Motor, Slip and its significance, Torque slip characteristics (qualitative). Necessity of a starter, Principle of operation Single Phase Induction Motor. Applications	

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2223-1.1	2	3												
EE2223-.2	2	3												
EE2223-2.3	2	3												
EE2223-2.4	2	3												
EE2223-2.5	2	3												

1: Low 2: Medium 3: High

TEXTBOOK

1.	Hughes, Edward, "Electrical Technology", Pearson Education Publications, 10th Edition, 2010.
2.	W.H. Hayt and J.E Kemmerley, “Engineering circuit Analysis”, McGrraw Hill, 8th Edition 2014
3.	Alexandar S Langsdorf, Theory of Alternating Current Machinery, McGrawhill

REFERENCE BOOKS:

1.	Vincent Del Toro, "Electrical Engineering Fundamentals", 2nd Edition, Pearson, 2015.
2.	H. Cotton, "Electrical Technology", CBS; 7th Edition, 2005.
4.	Debashisha Jena, "Basic Electrical Engineering", Wiley India Private Limited, 2012.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/108105053/

ELECTRICAL POWER QUALITY

Course Code:	**EE4221-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1, EE3102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concept of power quality and their classes
2.	To illustrate the voltage sags and interruptions, their sources, estimation & protection
3.	To analyze the transient over voltages, fundamentals of harmonics, harmonic sources & effects of harmonic distortions
4.	To discuss power quality bench marking process and utility interface
5.	To review the monitoring considerations and standards

UNIT-I

Definitions	**03 Hours**
General classes of power quality problems, Transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms	
Voltage sags and interruptions	**05 Hours**
Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, monitoring sags	
Transients over voltages	**08 Hours**
Sources of transient over voltages, principles of overvoltage protection, utility capacitor switching transients, fundamentals of harmonics: harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from Industrial loads, effects of harmonic distortion, intra-harmonics	

UNIT-II

Applied harmonics	**07 Hours**
Harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics	
Power quality benchmark	**08 Hours**
Introduction, benchmark process, power quality contract, power quality state estimation, including power quality in distribution planning, Interface to utility system, power quality issues, interconnection standards	

UNIT-III

Power quality monitoring	**09 Hours**
Monitoring considerations, power quality measurement equipment, assessment of power quality measurement data, application of intelligent systems and power quality monitoring standards	

Course Outcomes: At the end of the course student will be able to

1.	Describe various power quality issues to estimate voltage sag and performance
2.	Analyze transient over voltages & harmonics to understand the factors affecting the power quality
3.	Describe the principle for controlling the harmonics and filters to meet the standards
4.	Describe the power quality bench marking process and power quality contract to solve power quality issues
5.	Identify the Monitoring considerations, standards, measurement equipment, and application of intelligent systems

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE4221-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE4221-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE4221-1.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4221-1.4	2	3	-	-	-	-	-	-	-	-	-	2	-	1
EE4221-1.5	3	-	-	-	-	-	-	-	-	-	-	2	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Dugan, Roger C, Santoso, Surya, McGranaghan, Mark F/ Beaty, H. Wayne “Electric Power Quality” McGraw-Hill professional publication, 3rd edition, 2012

REFERENCE BOOKS:

1. G.T.Heydt, “Electric power quality”, Stars in a circle publications, 1991
2. M.H.Rashid, “Modern Power Electronics”, TATA McGraw Hill, 2002
3. Math H. J. Bollen. “Understanding Power Quality Problems Voltage Sags and Interruptions”, IEEE Press, 2000

INTEGRATION OF DISTRIBUTED GENERATION SYSTEMS

Course Code:	**EE4222-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2, EE2104-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To explain power generation by alternate energy source like wind power and solar power
2.	To explain selection of size of units and location for wind & solar systems
3.	To study the effects of integration of distributed generation on the performance the system
4.	To provide practical and useful information about grid integration of distributed generation
5.	To understand impact of integration of DG on power system stability and operation

UNIT-I

Distributed Generation — **11 Hours**

Introduction, status, properties of wind power, power distribution as a function of wind speed, solar power: status, properties, space requirements, photovoltaics, seasonal variation in production capacity, combined heat-and-power: status, options for space heating, hydropower: properties of large hydro, properties of small hydro, variation with time, tidal power, wave power, geothermal power, thermal power plant, Interface with the grid, power system performance: impact of distributed generation on the power system, aims of the power system, hosting capacity approach, power quality, voltage quality and design of distributed generation, hosting capacity approach for events, increasing the hosting capacity

Overloading and Losses — **04 Hours**

Impact of distributed generation, overloading: radial distribution networks, active power flow only, active and reactive power flow overloading: redundancy and meshed operation redundancy in distribution networks meshed operation, losses

UNIT-II

Protection system and energy management system — **03 Hours**

Increasing the hosting capacity: increasing the load ability building new connections, inter trip schemes, advanced protection schemes, energy management systems. power electronics approach, demand control, prioritizing renewable energy, dynamic load ability

Voltage Magnitude Variations — **06 Hours**

Impact of distributed generation, voltage margin and hosting capacity: voltage control in distribution systems, voltage rise owing to distributed generation, hosting capacity, estimating hosting capacity without measurements, sharing hosting capacity, Statistical approach to hosting capacity, increasing the hosting capacity: new or stronger feeders, alternative methods for voltage control accurate measurement of the voltage magnitude variations, allowing higher overvoltage’s overvoltage protection, over voltage curtailment compensating the generators voltage variations, distributed generation with voltage control, coordinated voltage control

Design of Distribution Feeders — **06 Hours**

Basic design rules, terminology, an individual generator along a medium-voltage feeder, low voltage feeders, series and shunt compensation, a numerical approach to voltage variations: example for two-stage boosting, general expressions for two- stage boosting tap changers with line- drop compensation: transformer with one single feeder, adding a generator. probabilistic methods for design of distribution feeders: need for probabilistic methods, the system studied, generation with constant production, adding wind power

UNIT-III

Power Quality Disturbances	**10 Hours**

Impact of distributed generation, fast voltage fluctuations: fast fluctuations in wind power, fast fluctuations in solar power, rapid voltage changes, very short variations. voltage unbalance: weaker transmission system, stronger distribution system, large single-phase generators, stronger distribution grid voltage unbalance, Low-frequency harmonics: wind power: induction generators, generators with power electronics interfaces, synchronous generators, measurement example, harmonic resonances, weaker transmission grid, and stronger distribution grid. High- frequency distortion: emission by individual generators, grouping below and above 2 kHz, limits below and above 2 kHz, voltage dips: synchronous machines balanced dips and unbalanced dips, induction generators and unbalanced dips, increasing the hosting capacity: strengthening the grid, emission limits for generator unit s, emission limits for other customers, higher disturbance levels, passive harmonic filters, power electronics converters, reducing the number of dips, broadband and high-frequency distortion

Course Outcomes: At the end of the course student will be able to

1.	Describe solar, wind, hydro and tidal power generation to understand the concepts of distributed generation
2.	Analyze the system performance on integrating the distributed generation system with the grid
3.	Analyze the effects of the DG integration to determine the increased risk of overload and system losses
4.	Describe the effects of DG integration to study the impact of power quality issues.
5.	Analyze the power quality disturbance to understand the impact of voltage dips on system load.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE4222-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4222-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE4222-1.3	1	2	3	-	-	-	-	-	-	-	-	-	-	-
EE4222-1.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4222-1.5	1	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Math Bollen, "Integration of Distributed Generation in the Power System", Wiley, 2011

REFERENCE BOOKS:

1. "Integration of distributed Energy resources in power system", oshihisa Funabashi Institute of Materials and Systems for Sustainability Nagoya University, Japan

ILLUMINATION TECHNOLOGY

Course Code:	**EE2321-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH1006-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the importance of Light
2.	To comprehend the propagation of light & photometric units
3.	To demonstrate the process of production of radiation and their characteristics
4.	To enumerate the principle of artificial light sources
5.	To design the objectives and methods for Interior lighting

UNIT-I

Light- Eye & Vision	**07 Hours**

Electromagnetic spectrum- visible spectrum- structure of the eye-Retina- Rods & Cones- distribution & functions of rods & cones-Photopic, Scotopic & Mesopic visions- Purkinje shift color-vision, vision functions – accommodation, adaptation & convergence- luminance contrast & color contrasts-metamerism

Propagation of light & photometric units	**08 Hours**

Light Propagation-Reflection-specular, diffuse, spread, compound, scattered & selective reflections. Absorption, transmission, refraction, polarization, Inter relation between the various photometric quantities, luminous efficacy, spectral eye sensitivity curve-light watt-brightness-luminous existence-radiometric quantities & units-point by point method of luminance calculations –problems

UNIT-II

Production of radiation	**08 Hours**

Sources of radiation, generation, coherent & incoherent radiations, Incandescence, Thermal Radiation, Black body radiator, Spectral energy distribution, (Energy-Wavelength) diagram, color temperature, c.t-selective, c radiators-color appearance & color rendering, Luminescence, Fluorescence-low pressure & high-pressure gaseous discharges, glow & arc discharges, V-I characteristics

Artificial light sources	**07 Hours**

Construction, principle of operation, luminous efficiency, lamp life & color characteristics of incandescence, Tungsten halogen, fluorescent, high pressure mercury vapor, High Pressure sodium vapor and metal halide lamps, new trends in lamp technology

UNIT-III

Interior Lighting Design	**06 Hours**

Lighting design objectives-safely and health performance-appearance & comport lighting design flow chart, Lighting for commercial and public buildings such as offices, hotels teaching establishments and hospital lighting, Lighting for industrial buildings, low & high bay area's general lighting designs, Lighting for display- Shops & super markets, art galleries, museum lighting, lumen method of calculations-simple problems

Light and health	**04 Hours**

Light as radiation, tissue damage by ultraviolet radiation, tissue damage by visible and near infrared radiation, tissue damage from infrared radiation beyond 1400 nm, threshold limit values, practical considerations, aging effects, risk of exceeding limits, using task lights, eyestrain, migraine, autism, visual comfort and human variability, light operating through the circadian system, sleep, blue light hazard

Course Outcomes: At the end of the course student will be able to

1.	Analyze the electromagnetic spectrum of light to justify the concepts of vision systems
2.	Describe the light propagation principle to illustrate the photometric parameters
3.	Describe the process of radiation to analyze and distinguish color rendering properties
4.	Apply the concept of artificial light sources to suggest efficient lighting system
5.	Design lighting systems to suggest interior and exterior in-addition to health safety

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2321-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2321-1.2	2	3	-	-	-	1	2	-	-	-	-	-	-	-
EE2321-1.3	2	3	-	-	-	1	2	-	-	-	-	-	-	-
EE2321-1.4	2	3	-	-	-	2	2	-	-	-	-	-	-	-
EE2321-1.5	2	2	3	-	-	1	2	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. M.A. Cayless and A.M Marsden, "Lamps and Lighting" (Ed.3) Oxford and IBH Publishing, 4th edition,1996

REFERENCE BOOKS:

1. Ronald N. Helms, "Illumination Engineering for Energy Efficiency Luminous Environment" PH ,1980
2. H. Ziji, "Illumination Engineering Course", -Philips Technical Lab,1955
3. Brain Fitt and Joe Thornley, "Lighting by Design –A Technical Guide", Focal Press,Boston,1992

OPERATION AND MAINTENANCE OF SOLAR ELECTRICAL SYSTEMS

Course Code:	**EE2322-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the solar radiation and PV technologies
2.	To familiarize with PV inverters and mounting methods of PV systems
3.	To examine the site assessment, design process of the grid connected system and its sizing
4.	To know the procedures of installation, commissioning and maintenance of PV systems
5.	To discuss the types of financial incentives available, calculation of payback time

UNIT-I

Solar Resource and Radiation — **03 Hours**

Solar resources, quantifying solar radiation, the effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays

PV Industry and Technology — **05 Hours**

Semiconductor devices, Mainstream technologies, Monocrystalline silicon, Multicrystalline/polycrystalline silicon, Thin film solar cells, Contacts, Buying solar modules, Standards, Certifications, Warranties, Emerging technologies, Dye-sensitized solar cells, Sliver cells, Heterojunction with intrinsic thin layer (HIT) photovoltaic cells, III-V Semiconductors, Solar concentrators, Characteristics of PV cells, Graphic representations of PV cell performance, Connecting PV cells to create a module, Specification sheets, creating a string of modules, Creating an array, Photovoltaic array performance, Irradiance, Temperature, Shading

Inverters, Other System Components and Mounting Systems — **07 Hours**

Introduction, Inverters, Battery inverters, Grid-interactive inverters, Transformers, Mainstream inverter technologies, String inverters, Multi-string inverter, Central inverter, Modular inverters, Inverter protection systems, Self-protection, Grid protection, Balance of system equipment: System equipment excluding the PV array and inverter, Cabling, PV combiner box, Module junction box, Circuit breakers and fuses, PV main disconnects/isolators, Lightning and surge protection, System monitoring, Metering, Net metering, Gross metering, Roof mounting systems, Pitched roof mounts, Pitched roof mounts for tiled roofs, Pitched roof mounts for metal roofs, Rack mounts, Direct mounts, Building-integrated systems, Ground mounting systems, Ground

UNIT-II

Site Assessment — **03 Hours**

Location of the PV array, Roof specifications, Solar Pathfinder, Solmetric Suneye, HORI catcher, iPhone apps, Software packages, Available area, Portrait installation, Landscape installation, Energy efficiency initiatives, Health, safety and environment (HSE) risks, Local environment, Locating balance of system equipment, Site plan

Designing, Sizing and Installing Grid-connected PV Systems — **08 Hours**

Design brief, Existing system evaluation, Choosing system components, Modules, Mounting structure, Inverters, Cabling, Voltage sizing, Current sizing, Monitoring, System protection, Over-current protection, Fault-current protection, Lightning and surge protection, Grounding/earthing, Mechanical protection, Array protection, Sub-array protection, Extra low voltage (ELV) segmentation, Matching voltage specifications, Calculating maximum voltage, Calculating minimum and maximum voltage, Calculating the minimum and maximum number of modules in a string, Matching current specifications, Matching modules to the inverter's power rating, Losses in utility-interactive PV systems, Temperature of the PV module, Dirt and soiling, Manufacturer's tolerance, Shading, Orientation and module tilt angle, Voltage drop, Inverter efficiency, Calculating system yield, PV array installation, DC wiring, Cabling routes and required lengths, Cable sizing, PV combiner box, System grounding/earthing, Inverter installation, Installation checklist, Interconnection with the utility grid, required information for installation, Safety

System Commissioning	**02 Hours**
Introduction, Final inspection of system installation, Testing, Commissioning, System documentation	
System Operation and Maintenance	**03 Hours**
System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, other common problems	
UNIT-III	
Marketing and Economics of Grid-connected PV Systems	**05 Hours**
Introduction, PV system costing, Valuing a PV system, Simple payback and financial incentives, Simple payback, Feed-in tariffs, Rebates, Tax incentives, Loans, Renewable portfolio standards and renewable energy certificates, Marketing, Insurance.	
Case Studies	**04 Hours**
Case studies of a variety of grid-connected PV systems- Case A to G	

Course Outcomes: At the end of the course student will be able to

1.	Describe basic concepts of solar cell to illustrate PV technologies
2.	Describe various PV inverter topologies & to suggest the methods of mounting the PV panels
3.	Describe the factors related to site assessment to design the grid connected systems
4.	Outline the process of PV installation and commissioning to operate & maintain the PV systems
5.	Analyze the economics of grid connected PV systems to calculate the payback time

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2322-1.1	3	-	-	-	-	1	2	-	-	-	-	-	-	-
EE2322-1.2	3	-	-	-	-	1	2	-	-	-	-	1	-	2
EE2322-1.3	3	-	-	-	-	1	-	-	-	-	-	1	-	-
EE2322-1.4	3	-	-	-	-	1	-	-	-	-	-	1	-	-
EE2322-1.5	2	3	-	-	-	1	1	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Geoff Stapleton and Susan Neill, "Grid-connected Solar Electric Systems", The Earthscan Expert Handbook for Planning, Design and Installation, Earthscan, 1st Edition, 2012

REFERENCE BOOKS:

1. Chetan Singh Solanki, "Solar Photovoltaics - Fundamentals, Technologies and Applications", PHI Learning Pvt. Ltd., 2015

ELECTRICAL POWER UTILIZATION

Course Code:	**EE3321-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2, EE2002-1 EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the types and working of various heating and welding equipment
2.	To be familiarized with the electrolysis process and its control using electrical power
3.	To select different traction equipment based on their characteristics and to control them
4.	To introduce to Illumination, its requirements and study the construction & working of different types of lamps
5.	To introduce electric and hybrid vehicles and associated technologies

UNIT-I

Heating and Welding — **09 Hours**

Advantages and methods of electric heating, resistance ovens, induction heating, dielectric heating, the arc furnace, heating of building, electric welding, resistance and arc welding, control device and welding equipment

Electrolytic Process — **07 Hours**

Fundamental principles, extraction, refining of metals, electroplating, Factors affecting electro deposition process, power supply for electrolytic process

UNIT-II

Electric Traction — **07 Hours**

System of traction, speed time curve, tractive effort at/ co-efficient of adhesions, selection of traction motors, method of speed control, energy saving by series parallel control

AC Traction Equipment — **07 Hours**

AC series motor, characteristics, regenerative braking, linear induction motor and their use, AC traction, diesel electric equipment, train lighting system, specific energy, factors affecting specific energy consumption

UNIT-III

Illumination — **06 Hours**

Laws of illumination, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps, incandescent, fluorescent, vapor and CFL and their working, Glare and its remedy

Introduction to Electric and Hybrid Vehicles — **04 Hours**

Block diagram explanation for electric and hybrid vehicles, Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement, vehicle performance and energy consumption

Course Outcomes: At the end of the course student will be able to

1.	List the various methods of electrical heating and welding to select an appropriate method for a given application
2.	Describe the fundamental principles of electrolytic processes of extraction and refinement of metals
3.	Select and control electric motors for traction to achieve energy savings

4.	Analyze the characteristics of AC traction motors, train lighting system and compute specific energy consumption
5.	Apply fundamentals of illumination to design lighting for a given application and outline the transmission requirements of EVs

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ **Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE3321-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3321-1.2	3	-	-	-	-	-	2	-	-	-	-	-	-	-
EE3321-1.3	2	3	-	-	-	-	2	-	-	-	-	-	-	-
EE3321-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3321-1.5	2	3	-	-	-	1	2	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. E.O. Taylor, Rao V V L, "Utilization Of Electric Energy", Orient Blackswan Pvt Ltd., New Delhi, 1st Edition
2. Mehrdad, Ehsani, Yimin Gao, Sabastien. E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vechiles", CRC Press,2nd edition,2009
3. S.L.Uppal, "Electrical Power", Khanna Publications, 3rd edition, 2009

REFERENCE BOOKS:

1. Soni Gupta and Bhatnager, "A Course in Electrical Power", Dhanapat Rai & sons.2008

INDUSTRIAL HEATING

Course Code:	**EE3322-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To explain construction, classification of industrial furnaces
2.	To know the different processes of heat transfer in industrial furnaces
3.	Explicate the heating capacity of continuous furnaces
4.	Discuss the methods of saving energy in industrial furnace systems
5.	Explain the operation and control of industrial furnaces

UNIT-I

Industrial Heating Processes and Heat Transfer in Industrial Furnaces	**07 Hours**
Industrial Process Heating Furnaces, Classifications of Furnaces, Elements of Furnace Construction, Heat Required for Load and Furnace, Flow of Heat Within the Charged Load, Heat Transfer to the Charged Load Surface, Determining Furnace Gas Exit Temperature, Thermal Interaction in Furnaces, Temperature Uniformity, Turndown	
Heating Capacity of Batch Furnaces	**08 Hours**
Definition of Heating Capacity, Effect of Rate of Heat Liberation, Effect of Rate of Heat Absorption by the Load, Effect of Load Arrangement, Effect of Load Thickness, Vertical Heating, Batch Indirect-Fired Furnaces, Batch Furnace Heating Capacity Practice, Controlled Cooling in or After Batch Furnaces	

UNIT-II

Heating Capacity of Continuous Furnaces	**07 Hours**
Continuous Furnaces Compared to Batch Furnaces, Continuous Dryers, Ovens, and Furnaces for <1400 F (<760 C), Continuous Midrange Furnaces, 1200 to 1800 F (650 to 980 C), Sintering and Pelletizing Furnaces, Axial Continuous Furnaces for Above 2000 F (1260 C), Continuous Furnaces for 1900 to 2500 F (1038 to 1370 C), Continuous Liquid Heating Furnaces	
Saving Energy in Industrial Furnace Systems	**08 Hours**
Furnace Efficiency, Methods for Saving Heat, Heat Distribution in a Furnace, Furnace, Kiln, and Oven Heat Losses, Heat Saving in Direct-Fired Low- Temperature Ovens, Saving Fuel in Batch Furnaces, Saving Fuel in Continuous Furnaces, Effect of Load Thickness on Fuel Economy, Saving Fuel in Reheat Furnaces, Fuel Consumption Calculation, Fuel Consumption Data for Various Furnace Types, Energy Conservation by Heat Recovery from Flue Gases, Energy Costs of Pollution Control	

UNIT-III

Operation and Control of Industrial Furnaces	**10 Hours**
Burner and Flame Types, Location, Flame Fitting, Unwanted NOx Formation, Controls and Sensors-Care, Location, Zones, Air/Fuel Ratio Control, Furnace Pressure Control Turndown Ratio, Furnace Control Data Needs, Soaking Pit Heating Control, Uniformity Control in Forge Furnaces, Continuous Reheat Furnace Control.	

Course Outcomes: At the end of the course student will be able to

1.	Describe the heating process and industrial furnace to outline the construction and classification
2.	Describe batch furnaces to study the methods of heat transfer in industries
3.	Describe the operation of continuous furnaces to compare with the batch furnaces
4.	Analyze the methods of saving energy to calculate fuel consumption & energy costs in industrial furnace systems
5.	Describe the operation of industrial furnaces to control furnaces using sensors

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3322-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3322-1.2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3322-1.3	3	-	-	-	-	-	-	-	-	-	-	-	-	1
EE3322-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3322-1.5	3	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. W. Trinks, M. H. Mawhinney, R. A. Shannon, R. J. Reed, J. R. Garvey, "Industrial Furnaces", Wiley, 6th Edition, 2004

REFERENCE BOOKS:

1. Barrie Jenkins, Peter Mullinger, "Industrial and Process Furnaces: Principles, Design and Operation", Butterworth-Heinemann

Professional Elective Courses (Power System Stream)

ELECTRICAL ESTIMATION AND COSTING

Course Code:	**EE2231-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2104-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To discuss market survey, estimates, purchase enquiries, tenders, comparative statement and payment of bills and Indian electricity act and some of the rules
2.	To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses
3.	To discuss design of lighting points and its number, total load, sub-circuits, size of conductor and different types of service mains and estimation of power circuits
4.	To discuss estimation of overhead transmission and distribution system and its components
5.	To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation

UNIT-I

Principles of Estimation — **06 Hours**

Introduction to Estimation and Costing, Electrical Schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, Labour Conditions, Determination of Cost Material and Labour, Contingencies, Overhead Charges, Profit, Purchase System, Purchase Enquiry and Selection of Appropriate Purchase Mode, Comparative Statement, Purchase Orders, Payment Of Bills, Tender Form, General Idea about IE Rule, Indian Electricity(IE) Act and IE Rules

Wiring — **10 Hours**

Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring, Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables, Main Switch and Distribution Board, Conduits and its accessories and Fittings, Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor, General rules for wiring, Design of Lighting Points, Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor, Current Density, Layout.

UNIT-II

Service Mains — **04 Hours**

Introduction, Types, Estimation of Underground and Overhead Service Connections

Design and Estimation of Power Circuits — **04 Hours**

Introduction, Important Considerations regarding Motor Installation Wiring, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter

Estimation of Overhead Transmission and Distribution Lines — **06 Hours**

Cross Arms, Pole Brackets and Clamps, Guys and Stays, Conductors Configuration Spacing and Clearances, Span Lengths, Lightning Arrestors, Phase Plates, Danger Plates, Anti Climbing Devices, Bird Guards, Beads of Jumpers, Muffs, Points to be Considered at the Time of Erection of Overhead Lines, Erection of Supports, Setting of Stays, Fixing of Cross Arms, Fixing of Insulators, Conductor Erection. Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulators, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead

Lines, Clearances of Conductor from Ground, Spacing Between Conductors, Important Specifications

UNIT-III

Estimation of Substations	**10 Hours**

Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, Equipment for Substation, Substation Auxiliaries Supply, Substation Earthing

Course Outcomes: At the end of the course student will be able to

1.	Discuss market survey, estimates, purchase enquiries, preparation of tenders, comparative statements and payment of bills to know about the process of estimation
2.	Discuss design of lighting points, total load, sub-circuits and size of conductor of conductor to estimate its cost
3.	Discuss the distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses to be installed in a building
4.	Discuss overhead transmission and distribution system and its components to estimate its cost
5.	Discuss main components of a substation to prepare the single line diagram, earthing and estimation of a substation

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2231-1.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2231-1.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
EE2231-1.3	2	2	2	-	-	-	-	-	-	-	-	-	-	1
EE2231-1.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
EE2231-1.5	2	-	-	-	-	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. J. B. Gupta, "A Course in Electrical Installation Estimating and Costing", Katson Books, 9th Edition, 2012

REFERENCE BOOKS:

1. Raghavendra Rao, "Electrical Estimation and Electrical Wiring Systems", Sapna Book House, 2014

POWER SYSTEM PLANNING

Course Code:	**EE3231-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2104-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To discuss primary components of power system planning namely load forecasting, evaluation of energy resources
2.	To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution
3.	To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions
4.	To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.
5.	To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity

UNIT-I

Power System — **08 Hours**

Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organisation, Regulation, Scenario Planning, Electricity Forecasting: Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System

Power System Economics — **08 Hours**

Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation UNIT s, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment, Optimum Investment, Tariffs, Generation Expansion: Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies, Distributed Power Generation, Renovation and Modernization of Power Plants

UNIT-II

Transmission Planning — **04 Hours**

Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage

Distribution — **06 Hours**

Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity, Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification, Villages Self – Sufficiency in Energy, Community Power, Self – Generation

Reliability and Quality — **05 Hours**

Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Quality of Supply, Reliability and Quality Roadmap.

UNIT-III

Demand-Side Planning	**04 Hours**
Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit	
Electricity Market	**05 Hours**
Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Locational Marginal Pricing, Transmission Charges, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market	

Course Outcomes: At the end of the course student will be able to

1.	Describe primary components of power system planning, load forecasting for forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools
2.	Apply planning methodology for optimum power system expansion, various types of generation, transmission and distribution
3.	Evaluate the operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions
4.	Describe reliability criteria for generation, transmission, distribution & reliability evaluation and analysis.
5.	Describe the planning and implementation of electric-utility activities designed to influence consumer uses of electricity

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3231-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	1
EE3231-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3231-1.3	2	2	3	-	-	-	-	-	-	-	-	-	-	-
EE3231-1.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3231-1.5	3	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. A. S. Pabla, "Electric Power Planning", McGraw Hill, 2nd edition 2016

REFERENCE BOOKS:

1. Hossein Seifi, Mohammad Sadegh Sepasian, "Electric Power System Planning- Issues, Algorithms and Solutions", Springer

SMART ELECTRIC GRID

Course Code:	**EE3232-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3102-1, EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the Information and Communication Technologies related to smart grid
2.	To understand the Information security and different sensing and automation techniques
3.	To know the principles of Distribution management systems and transmission system operation for smart equipment
4.	To study the power quality issues and their management in smart grid
5.	To know the importance of micro grids and distributed energy resources

UNIT-I

Smart Grid	**02 Hours**
Introduction, Overview of the technologies required for the Smart Grid	
Information and Communication Technologies	**10 Hours**
Data communication, Switching techniques, Communication channels, layered architecture and protocols Ethernets, Wireless Lan, Bluetooth and Zigbee communication technology, Introduction, Encryption and decryption, Authentication, Digital signatures, Cyber security standards	
Sensing, Measurement, Control and Automation Technologies	**04 Hours**
Smart metering - An overview of the hardware used, Communications infrastructure and protocols for smart metering.	

UNIT-II

Distribution automation equipment and Management systems	**04 Hours**
Introduction, Data sources and associated external systems, Modelling and analysis tools,	
Transmission system operation	**04 Hours**
Introduction, Data sources, Energy management systems, Wide area applications	
Power electronics in Smart Grid	**07 Hours**
Introduction, Renewable energy generation, Photovoltaic systems, Wind, hydro and tidal energy systems, Fault current limiting	

UNIT-III

Power Quality Issues in Smart Grid	**09 Hours**
Power Quality issues, Power Quality Monitoring in smart Grid: Mitigation Methods, EMC Related Phenomena in Smart Electrical Power Systems, Energy Storage Systems	

Course Outcomes: At the end of the course student will be able to

1.	Identify various Information and Communication Technologies to learn the usage in electric grid
2.	Illustrate the Information security and automation techniques for protection and automation of smart electric grid
3.	Describe the principles of Distribution management systems and transmission system operation for smart equipment
4.	Illustrate the interfacing of power electronics devices to learn integration renewable energy

	sources to smart grid
5.	Describe power quality issues, power conditioners and monitor system to monitor the health of smart electric grid

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE3232-1.1	2	3	-	-	-	1	-	-	-	-	-	-	-	-
EE3232-1.2	2	3	-	-	-	1	-	-	-	-	-	1	-	-
EE3232-1.3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
EE3232-1.4	2	3	-	-	-	-	-	-	-	-	-	1	-	1
EE3232-1.5	2	3	-	-	-	1	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Janaka Ekanayake, Kithsiri Liyanage, "Smart Grid - Technology And Applications", John Wiley & Sons, Ltd., Publication, 2012

REFERENCE BOOKS:

1. Ryszard Strzelecki, Grzegorz Benysek, "Power Electronics in Smart Electrical Energy Networks", Springer Publication, ISBN-13: 9781848003170, 2008
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", P.E, The Fairmont Press, Inc.2009
3. James Momoh, "Smart Grid - Fundamentals of Design and Analysis", IEEE Press, A JOHN WILEY & SONS, INC., PUBLICATION – 2012.
4. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.
5. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
6. Jean Claude Sabonnadiere, Nouredine Hadjsaid, "Smart Grids", Wiley Blackwell.
7. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc.

FACTS and HVDC

Course Code:	**EE3233-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1, EE2001-1, EE2102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce FACTS controllers and its associated power electronics concepts.
2.	To study various FACTS devices and their control
3.	To know the various aspects of High Voltage DC converters
4.	To study control schemes of HVDC converters and the requirements of smoothing reactor.

UNIT-I

FACTS-Introduction	**05 Hours**

Basics of power transmission networks - control of power flow in AC - transmission line, Transmission, interconnection, power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters. Classification of flexible AC transmission system controllers, Benefits of FACTS Controller – application of FACTS controllers in distribution systems.

Shunt and Series Compensation	**04 Hours**

Objectives of Shunt Compensation, Midpoint voltage regulation for line segmentation, End of line voltage support to prevent voltage instability, Objectives of series Compensation, Improvement of Transient stability, Power oscillation damping.

Variable Impedance FACTS controllers	**06 Hours**

Static Var compensator: Methods of controllable Var generation, Analysis of SVC – Power angle curve with SVC, Configuration of SVC- FC-TCR, TSC-TCR, SVC Controller – Block diagram of SVC Voltage Controller, Susceptence Regulator, modeling of SVC – applications of SVC.

UNIT-II

Thyristor and GTO Controlled Series Capacitor	**05 Hours**

Introduction - basic concepts of controlled series compensation -operation of TCSC - analysis of TCSC- control of TCSC - GTO thyristor controlled series capacitor (GCSC) - mitigation of sub synchronous resonance with TCSC and GCSC - applications of TCSC

VSC Based FACTS Controllers	**05 Hours**

Static Synchronous Compensator (STATCOM): Introduction - principle of operation of STATCOM - a simplified analysis of a three phase six pulse STATCOM - analysis of a six pulse VSC using switching functions - multi-pulse converters. Control of type 2 converters - control of type I Converters - multilevel voltage source converters - applications of STATCOM.

SSSC and UPFC	**05 Hours**

:SSSC-operation of SSSC , control of power flow – Description, modeling of SSSC, control of SSSC using Type-2 and Type-1 VSC,
Introduction to Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC) – Basic operating principles.

UNIT-III

HVDC Converters:	**05 Hours**

DC Power Transmission Technology: Introduction, comparison with AC transmission, application of DC transmission. Introduction to Line commutated converter, choice of converter configuration for any pulse number, analysis of 6 pulse Graetz bridge converter without overlap, effect of source inductance. Analysis of converter in two and three, and three and four valve conduction modes.

Control of Converters and HVDC link:	**05 Hours**

DC link control principles, converter control characteristics, firing angle control, current and extinction angle control, Starting and stopping of DC link, Power control, Frequency control, Reactive power control, Tap changer control, Emergency control and Telecommunication requirements.

Course Outcomes: At the end of the course student will be able to

1.	Describe various FACTS controllers required for control of active and reactive power flow in a transmission network.
2.	Design Shunt compensation schemes for the improvement of transient stability and damping of power oscillations
3.	Analyze the working of static shunt compensation schemes using SVC and STATCOM for voltage and reactive power control
4.	Analyze various series compensation schemes using variable impedance and VSC based series FACTS controllers for controlling / routing the power through the desired transmission paths.
5.	Analyze different converter circuits configuration to select best converter configuration for HVDC power transmission

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3233-1.1	3	3	-	-	-	-	-	-	-	-	-	-1	-	-
EE3233-1.2	3	3	-	-	3	-	-	-	-	-	-	1	-	-
EE3233-1.3	3	3	-	-	3	-	-	-	-	-	-	1	-	-
EE3233-1.4	3	3	-	-	3	-	-	-	-	-	-	1	-	-
EE3233-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International, 2012.
2. K.R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International, 2007.
3. E.W.Kimbark "Direct Current Transmission", Vol.1, Wiley Inter-Science, London, 2006.

REFERENCE BOOKS:

1. Arrilaga, "High Voltage Direct Current Transmission", The Institute of Engineering and Technology, 2ndEdition, 2007.
2. S Kamakshaiah and V Kamaraju, "HVDC Transmission", TMH, 2011.
3. Narain G. Hingorani,Laszlo Gyugyi, "Understanding FACTS", IEEE Publications, US, 2000.

E RESOURCES:

1. https://nptel.ac.in/courses/108107114
2. https://nptel.ac.in/courses/108106160

COMPUTER TECHNIQUES IN POWER SYSTEM ANALYSIS

Course Code:	**EE3234-1**	**Course Type:**	**PEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE2005-1, EE2104-1, EE2102-1, EE3102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concepts of network topology and graph theory
2.	To Formulate the Y Bus and Z Bus
3.	To Formulate and solve load flow problem of a power system network.
4.	To justify the need of Economic operation of power system

UNIT-I

Network Topology and Matrices — **15 Hours**

Introduction, Elementary graph theory –oriented graph, tree, co-tree, basic cut-sets, basic loops; Incidence matrices –Element-node, Bus incidence, Branch – path, Basic cut-set, Augmented cut-set, Basic loop and Augmented loop; Primitive network – impedance form and admittance form.
Formation of Y_{BUS} – by method of inspection, by method of singular transformation ($Y_{BUS} = A^T [y] A$)
Formulation of Z_{Bus} building algorithm without mutual coupling between the elements by addition of link and addition of branch. Illustrative examples.

UNIT-II

Load Flow Studies — **15 Hours**

Introduction, Power flow equations, Classification of buses, Data for load flow, Gauss-Seidel Method – Algorithm and flow chart for PQ and PV buses (numerical problem for one iteration only), Acceleration of convergence; Newton Raphson Method – Algorithm and flow chart for NR method in polar coordinates (numerical problem for one iteration only); Algorithm for Fast Decoupled load flow method; Comparison of Load Flow Methods.

UNIT-III

Economic Operation of Power system — **07 Hours**

Introduction, Performance curves, Economic generation scheduling neglecting losses and generator limits, Economic generation scheduling including generator limits and neglecting losses; Iterative techniques; Economic Dispatch including transmission losses – approximate penalty factor, iterative technique for solution of economic dispatch with losses; Derivation of transmission loss formula;

Unit Commitment — **03 Hours**

Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only)

Course Outcomes: At the end of the course student will be able to

1.	Apply graph theory concepts to form bus, cut set and loop incidence matrices.
2.	Build Y_{bus} and Z_{bus} to model the connected power system network.
3.	Apply, compare and analyze various load flow techniques to compute the parameters affecting the power flow at all buses & line flows.
4.	Apply various numerical integration techniques to predict system stability.
5.	Prepare generation scheduling to operate power system economically.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE3234-1-1.1	3	3	-	-	3	-	-	-	2	2	-	1	-	2
EE3234-1-1.2	3	3	-	-	3	-	-	-	2	2	-	1	-	2
EE3234-1-1.3	3	3	3	1	3	-	-	-	2	2	-	1	-	2
EE3234-1-1.4	3	3	3		3	-	-	-	2	2	-	1	-	2
EE3234-1-1.5	3	3	3	1	3	-	-	-	2	2	-	1	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Stag, G. W., and EI-Abiad, A. H, “Computer Methods in Power System Analysis”, McGraw Hill International Student Edition. 1968
2. Nagrath, I. J., and Kothari, “Modern Power System Analysis”, D. P., -TMH,4th edition, 2011.

REFERENCE BOOKS:

1. Haadi Sadat, “Power System Analysis”, -TMH, 3rd edition, 2010.
2. Singh, L. P., “Advanced Power System Analysis and Dynamics”, New Academic 2012

E Books / MOOCs/ NPTEL

1. NPTEL Course on Computer Aided Power System Analysis, Prof. Biswarup Das, IIT Roorkee

HIGH VOLTAGE ENGINEERING

Course Code:	**EE3331-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2104-1, EE2102-1, EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concept of high voltage technology
2.	To familiarize with concept of HV breakdown phenomena of dielectrics
3.	To study methods of generation of HVAC and HVDC voltages and concept of generation of impulse voltage and current
4.	To introduce the concept of measurement of high voltages.
5.	To study the non-destructive insulation techniques and high voltage tests on electrical apparatus.

UNIT-I

Introduction	**05 Hours**

Introduction to HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory. Important applications of high voltage.
Types of HV insulators, Cables and bushings,

Breakdown Phenomena	**10 Hours**

Classification of HV insulating media. Properties of important HV insulating media under each category. Gaseous dielectrics: Ionizations: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory breakdown in non-uniform fields, Corona discharges. Breakdown in electro negative gasses. Paschen's law and its significance, Time lags in breakdown

UNIT-II

Generation Of HV AC And DC Voltage	**08 Hours**

HV AC-HV transformer; Need for cascade connection and working of transformers units connected in cascade. Series resonant circuit principle of operation and advantages. Tesla coil. HV DC- voltage doubler circuit. Calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop Cock Croft- Walton type high voltage DC set

Generation of Impulse Voltage and Current	**07 Hours**

Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator - working of Marx impulse, rating of impulse generator, components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Triggetron gap and oscillograph time sweep circuits. Generation of switching impulse voltage.

UNIT-III

Measurement of High Voltages	**08 Hours**

Electrostatic voltmeter principle, construction and limitation. Chubb and Fortescue method for HV AC measurement. Generating voltmeter Principle, construction. Series resistance micro ammeter for HV DC measurements. Standard sphere gap measurements of HV AC, HV DC & impulse voltage, Factors affecting the measurements, Potential dividers, capacitance dividers, mixed Rc potential dividers,

Surge measurement:	**02 Hours**

Klydanograph and magnetic links, Introduction to partial discharges (PD), PD measurement.

Course Outcomes: At the end of the course student will be able to

1.	Describe the basics of HV technology and analyze the breakdown phenomenon to understand the properties of gaseous dielectrics.
2.	Analyze breakdown mechanisms in solid & liquid dielectrics, high AC and DC voltage generation to compute parameters of voltage doubler circuit.
3.	Describe the generation of impulse voltages and currents needed to test the insulting medium.
4.	Analyze high voltage and current measurement techniques to study the factors affecting the measurement.
5.	Describe non-destructive insulation testing methods to study testing of high voltage apparatus.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3331-1.1	3	3	-	-	-	-	-	-	-	-	-			
EE3331-1.2	3	3	-	-	-	-	-	-	-	-	-	-		
EE3331-1.3	3	3	-	-	-	-	-	-	-	-	-	-		
EE3331-1.4	3	3	-	-	-	-	-	-	-	-	-	-		
EE3331-1.5	3	3	-	-	-	-	-	-	-	-	-	-		

TEXTBOOKS:

1. M S Naidu & V Kamaraju, "High Voltage Engineering", 4th Edition, THM, 2008
2. C L Wadhwa, "High Voltage Engineering", New Age International Private limited, 3rd edition, 2010.

REFERENCE BOOKS:

1. E Kuffel & W S Zeengl , "High Voltage Engineering Fundamentals", 2nd edition, Elsevier, press, 2005.

POWER SYSTEM DYNAMICS AND STABILITY

Course Code:	**EE4331-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3102-1, EE2001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the system modelling and dynamics of synchronous generator
2.	To model the load connected to power system and analyze its small signal stability
3.	To introduce various excitation and prime mover controllers
4.	To model various prime movers
5.	To carry out transient analysis of power system and understand the importance of stability controllers

UNIT-I

System Modeling and Dynamics of Synchronous Generator	**08 Hours**
Basic concepts, Review of classical methods, modeling of synchronous machine, Swing equation, Park's transformation – Park's voltage equation, Park's mechanical equation (torque). Applications– (a) Voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator. Solution for transient analysis, Operational impedance, Relationship between Tdo' and Tdo"	
Load Modeling	**07 Hours**
Introduction, Approaches – Polynomial model and Exponential model. Small Signal Angle Stability: Small signal angle stability with SMIB system, detailes model of SMIB	

UNIT-II

Excitation and Prime Mover Controllers	**08 Hours**
Introduction, Types of excitation, AVR with and without ESS, TGR, Amplifier PSS, Static exciters	
Modeling of Prime Movers	**08 Hours**
Introduction, Major components, Block diagram, Hydraulic turbine, Steam turbine	

UNIT-III

Transient Stability Analysis	**09 Hours**
Simulation for Transient stability Evaluation, Transient stability controllers	

Course Outcomes: At the end of the course student will be able to

1.	Model the synchronous generator for understanding its dynamics
2.	Apply techniques to model the load to understand the dynamics of load and SMIB system
3.	Describe the concept of excitation and prime mover controllers used in the voltage regulation
4.	Describe the various components to model the prime mover
5.	Perform the transient stability analysis to understand the importance of stability controller

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE4331-1.1	3	-	-	-	2	-	-	-	-	-	-	-	-	3
EE4331-1.2	2	3	-	-	2	-	-	-	-	-	-	-	-	1
EE4331-1.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4331-1.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4331-1.5	2	2	3	-	-	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Padiyar K.R., "Power System Dynamics, Stability and Control", BPB Publications, 2002.
2. Prabha Kunder, "Power System Stability and Control",McGraw- Hill Publishing Company, 1ST Edition, 2006

REFERENCE BOOKS:

1. Marija Ilic; John Zaborszky, Dynamics and Control of Large Electric Power Systems", IEEE Press and John Wiley & Sons, Inc.2000
2. Paul M. Anderson and A. A. Fouad, "Power System Control and Stability Revised Printing" John Wiley & Sons, Inc. 2002
3. Arthur Bergen, "Power System Analysis ", Second Edition. Pearson India 2002

REACTIVE POWER MANAGEMENT

Course Code:	**EE4332-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2005-1, EE2104-1, EE3102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concept of reactive power, its generation and absorption in power system
2.	To illustrate various methods of voltage or reactive power control
3.	To demonstrate the principle of transmission system compensation, Effect of harmonics on reactive power control
4.	To comprehend the concept of resonance, shunt capacitors and filters
5.	To explain the reactive power coordination techniques

UNIT-I

Introduction	**08 Hours**
Importance of reactive power control in Electrical Power System, Generation and absorption of Reactive power, Relation between Voltage, Power and Reactive power at a node	
Methods of voltage or Reactive power control	**08 Hours**
Shunt reactor, Shunt capacitor, Series capacitor, Synchronous condenser, Static VAR system	

UNIT-II

Transmission system compensation	**08 Hours**
Principles of Transmission system compensation, Effect of Harmonics on reactive power control: Harmonic sources	
Harmonics	**07 Hours**
Resonance, Shunt capacitors and Filters, Telephonic Interference	

UNIT-III

Reactive power coordination	**09 Hours**
Reactive power management, Transmission benefits, Reactive power dispatch and equipment impact	

Course Outcomes: At the end of the course student will be able to

1.	Describe the importance of reactive power, its generation and absorption in power system
2.	Analyze methods utilized to control the voltage or reactive power
3.	Describe the compensation techniques and effect of harmonics on reactive power in a transmission system
4.	Analyse effect of shunt capacitors, filters and telephonic interference on transmission system
5.	Describe the reactive power coordination techniques to manage the reactive power in a system

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE4332-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4332-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE4332-1.3	3	-	-	-	-	-	-	-	-	-	-	-	-	1
EE4332-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3332-1.5	3	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. T.J.E. Miller,"Reactive Power Control in Electric Systems", John Wiley sons NY, 1982
2. B.M.Weedy, "Electric Power Systems, John Wiley Sons", 2nd edition, 2012

REFERENCE BOOKS:

1. Prabha Kundur, "Power System Stability and Control", Tata Mc Graw-Hill,1st edition,2006.
2. IEEE Guide on Harmonic control & Reactive compensation of Power converters – IEEE student 519 – 1981

POWER SYSTEM OPERATION & CONTROL

Course Code:	**EE4333-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2005-1, EE2104-1, EE2001-1, EE3102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Explain the importance of Control Center and SCADA system in Power system operation.
2.	Study the operation of Automatic Generation Control system in Power system.
3.	Understand the generation and absorption of reactive power and methods of voltage control
4.	Understand the importance and study of various methods of Unit
5.	Study the various factors affecting the Power system security and contingency analysis

UNIT-I

CONTROL CENTER OPERATION OF POWER SYSTEMS — **08 Hours**

Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, expression for tie-line flow and frequency deviation, parallel operation of generators, area lumped dynamic model

AUTOMATIC GENERATION CONTROL — **08 Hours**

Automatic voltage regulator, automatic load frequency control, AVR control loops of generators, performance of AVR, ALFC of single area systems, concept of control area, multi-area systems, POOL operation-two area systems.

UNIT-II

CONTROL OF VOLTAGE AND REACTIVE POWER — **08 Hours**

Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, single machine infinite bus systems, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse.

UNIT COMMITMENT — **07 Hours**

Statement of the problem, need and importance of Unit commitment, methods- dynamic programming method, constraints, spinning reserve, and examples.

UNIT-III

POWER SYSTEM SECURITY — **09 Hours**

Factors affecting power system security, power system contingency analysis, detection of network problems, network sensitivity methods, calculation of network sensitivity factor, contingency ranking

Course Outcomes: At the end of the course student will be able to

1.	Describe the control Centre operation of power system to understand the tie line power flow and frequency deviation
2.	Analyze the effect of Automatic Voltage Regulator and Automatic Generation Control on Load Frequency Control of single and two area systems
3.	Analyze the effect of reactive power control on Voltage stability and voltage collapse at a load bus
4.	Apply various methods unit commitment for optimum operation of generation systems
5.	Analyze the various factors affecting the security power system for contingency ranking.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2
EE4333-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4333-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4333-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4333-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4333-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Wood & B A J F Woollenberg, "Power generation, operation and control"- John Wiley and Sons, 2nd edition,1996
2. B. M. Weedy, "Electric Power Systems" Wiley-Blackwell publication, 5th edition, 2012.
3. P.S.R.Murthy , "Power Systems Operation and Control", TMH

REFERENCE BOOKS:

1. K Uma Rao, "Power System: Operation & Control", Wiley India, 2012
2. Nagrath and Kothari, "Modern Power System Analysis", 4TH edition, MHE, 2011
3. W.D Stevenson, "Elements of Power System Analysis", 4TH edition, TMH, 2001.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108101040

Professional Elective Courses (Microelectronics Stream)

ARM SYSTEM ARCHITECTURE

Course Code:	**EE3241-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2003-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the architecture, internal functioning and assembly instructions of ARM core
2.	To comprehend the functionality, interfacing, and programming of ARM core
3.	To understand the floating-point representation and VFP coprocessor implementation
4.	To outline details of cache architectures, AMBA bus, virtual memory management concepts with the detailed explanation on the Memory Management Unit (MMU) and Memory Protection Unit (MPU)
5.	To illustrate the overview of various peripherals used with ARM core and review of big. LITTLE technology for various ARM processor

UNIT-I

ARM Introduction and Pipeline structures	**08 Hours**

Types of computer Architectures, ISA's and ARM history. Embedded system software and hardware, stack implementation in ARM, endianness, and condition codes. Processor core vs CPU core, ARM7TDMI interface signals, memory interface, Bus cycle types, Register set, Operational modes. Instruction format, ARM Core dataf model, ARM 3 stage pipeline, ARM family attribute comparison. ARM 5 stage pipeline, Pipeline hazards, Data forwarding - a hardware solution

ARM7TDMI assembly instructions and modes	**08 Hours**

ARM ISA and Processor variants, Different types of instructions, ARM instruction set, data processing instructions. Shift operations, shift operations using RS lower byte, Immediate value encoding. Data processing instructions. AddressingMode-1, Addressing Mode -2. Addressing Mode -2, LDR/STR, Addressing mode -3 with examples. Instruction timing, Addressing Mode - 4 with examples. Swap instructions, Swap register related instructions, Loading constants. Program control flow, Control flow instructions, B & BL instructions, BX instruction. Interrupts and Exceptions, Exception Handlers, Reset Handling. Aborts, software Interrupt Instruction, undefined instruction exception. Interrupt latency, Multiply instructions, and Instruction set examples. Thumb state, Thumb programmers model, Thumb implementation, Thumb applications. Thumb instructions, Interrupt processing. Interrupt handling schemes, Examples of interrupt handlers.

UNIT-II

Interface	**07 Hours**

ARM Coprocessor interface and Vector Floating Point Processor (VFP) ARM coprocessor interface and instructions, Coprocessor instructions, data processing instruction, data transfers, register transfers. Number representations, floating point representation (IEEE754). Flynn's taxonomy, SIMD and Vector processors, VFP and ARM interactions, An example vector operation

Cache and Memory Management and Protection	**08 Hours**

Memory technologies, Need for memory hierarchy, Hierarchical memory organization, Virtual memory. Cache memory, Mapping functions, Cache design, Unified or split cache, multiple level of caches, ARM cache features, coprocessor 15 for system control. Processes, memory map, protected systems, ARM systems with MPU, Memory Protection Unit (MPU). Physical Vs virtual memory, Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly Coupled Memory (TCM).

UNIT-III	
ARM tools and peripherals ARM development environment	**09 Hours**
Arm Procedure Call Standard (APCS), example C program. Embedded software development, image structure, linker inputs and outputs, memory map, application startup. AMBA overview, typical AMAB based microcontroller, AHB bus features, AHB bus transfers, APB bus transfers, APB bridge. DMA, Peripherals, Programming peripherals in ARM. big. LITTLE technology ARM ISAs, ARMv5, ARMv6, ARM v7, ARMv8..	

Course Outcomes: At the end of the course student will be able to

1.	Describe architecture, internal functioning and assembly instructions of ARM7TDMI to comprehend basics of ARM
2.	Apply ARM7 based assembly level programming skills to perceive the various coprocessors interfaced in an SoC.
3.	Describe the cache design, virtual memory, memory protection concepts to visualize the implementation in a typical SoC designs
4.	Describe AMBA bus architecture, various HW peripherals in SoCs to build their design aspects
5.	Apply processor software tool chains for embedded software solution development

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3241-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3241-1.2	2	3	-	-	-	-	-	-	-	-	-	1	-	-
EE3241-1.3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
EE3241-1.4	2	3	-	-	-	-	-	-	-	-	-	2	-	-
EE3241-1.5	2	3	-	-	-	-	-	-	-	-	-	2	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Andrew Sloss, Dominic Symes, Chris Wright, Morgan, "ARM System Developer's Guide : Designing and Optimizing System Software", (English) 1st Edition, Kaufmann Publishers 2011

REFERENCE BOOKS:

1.	Steve Furber, "Arm System-on-chip Architecture", 2nd Edition, Pearson publication, 2013
2.	William Hohl, Christppher Hinds,"Arm Assembly Language, Fundamentals and Techniques", 2nd edition, CRC Press, 2014
3.	Muhammad Ali Mazidi, "ARM Assembly Language Programming & Architecture", Kindle edition
4.	William Stallings "Operating Systems", 5th Edition
5.	Manuals and Technical Documents from the ARM Inc, web site.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/117106111

VLSI CIRCUITS AND DESIGN

Course Code:	**EE3242-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1002-2, EE2101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the VLSI Technology, its components and characteristics.
2.	To examine the electrical characteristics of MOS transistors.
3.	To demonstrate the design procedure, rule to be followed and the concept of MOSFET Scaling in VLSI.
4.	To illustrate the Geometry Effects and characteristics of MOS Inverters and universal gates.
5.	To discuss advanced techniques and applications to CMOS logic circuits.

UNIT-I

Basic CMOS Processing	**07 Hours**

(Introduction to IC Technology, Moore's law, VLSI design flow, VLSI Technology, Realisation of logic circuits using CMOS technology. Wafer fabrication process using Czochralski method, Photolithography, Well and Channel Formation, Gate oxide, Gate and Source/Drain formation, Contact & Metallization, fabrication of nMOS Transistor, Depletion type and Enhancement type MOS, CMOS n-well and P-well process,

MOS TRANSISTORS (Electrical Characteristics)	**08 Hours**

Two terminal MOS structure, flat band voltage, MOS system under external bias, structure and operation of MOS transistors, threshold voltage, drain to source current Ids verses Vds relationships, body effect, channel length modulation, mobility variation, Tunneling, punch through, hot electron effect Drain Induced Barrier Lowering (DIBL), Small signal AC characteristic models

UNIT-II

Design	**04 Hours**

Mask Layer, Stick Diagram for Boolean expressions, Symbolic diagram, Layout Sheet resistance, capacitance layer, inverter delays, rise time, fall time, cascading and super buffer.,

Scaling	**04 Hours**

MOSFET scaling and geometry effects: Introduction, constant field scaling, constant voltage scaling, short channel Effects, narrow channel effects, Comparison of MOSFET parameters due to scaling

Application-MOS Inverters Static Characteristics	**08Hours**

Introduction, voltage transistor characteristics, noise immunity and noise margin, power and area considerations, resistive load inverter calculation of Voh, Vol, Vil, Vih, inverters with n type MOSFET load characteristics, CMOS inverter static characteristics (excluding derivation) design of CMOS inverter, latch up bulk CMOS

UNIT-III

Application- 2 input NOR and NAND gates	**09 Hours**

Concept MOS based 2 input NOR and NAND gate (with derivation), CMOS based 2 input NOR and NAND gate (excluding derivation) Application- Other Forms of CMOS Logic: Pseudo nMOS logic, dynamic CMOS logic, clocked CMOS logic, CMOS domino logic, parity generator, multiplexer, dynamic shift registers.

Course Outcomes: At the end of the course student will be able to

1.	Illustrate the CMOS VLSI design flow to outline the CMOS IC fabrication process
2.	Analyze the structure, operation of MOS transistor to study the electrical characteristics.
3.	Use layout design rules to sketch CMOS logic circuits & compare effect of scaling on MOSFET parameters.
4.	Analyze MOS static characteristics to design the NMOS and CMOS inverter circuits.
5.	Design logic circuits using MOS transistors to study the IC fabrication aspects.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO**	
↓ Course Outcomes													1	2
EE3242-1.1	3	3	-	-	1	-	-	-	-	-	-	1	-	1
EE3242-1.2	3	3	-	-	2	-	-	-	-	-	-	1	-	1
EE3242-1.3	3	3	-	-	2	-	-	-	-	-	-	1	-	1
EE3242-1.4	3	3	-	-	2	-	-	-	-	-	-	1	-	1
EE3242-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3:High

TEXTBOOKS:

1.	Sang Mo Kang, Usuf Leblebici,"CMOS Integrated Circuit Analysis And Design", 3rd Edition, TATA Mc Graw hill edition,2002
2.	Douglass A Pucknell, Amran Esharaghian, "Basic VLSI Design", 3rd edition, PHI Publication,2009.
3.	Neil Weste and David Harris, "CMOS VLSI Design" 4th edition, Addison-Wesley,2010.

REFERENCE BOOKS:

1.	Wayne, Wolf, "Modern VLSI design: System on Silicon" Pearson Education, 2nd Edition,2005.
2.	Carver Mead and Lynn Conway" Introduction to VLSI Systems" BS Publication,1st edition,1979.

E Books / MOOCs/ NPTEL

1.	NPTEL Course on Digital VLSI Testing by Prof. Santanu Chattopadhyay, IIT Kharagpur
2.	NPTEL Course on CMOS Digital VLSI Design by Prof. Sudeb Dasgupta, IIT Roorkee
3.	NPTEL Course on VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur

VLSI LAYOUT TECHNIQUES

Course Code:	**EE4241-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3242-1, EE3344-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To Describe basic physics and operation of MOS devices
2.	To comprehend the process of Semiconductor Fabrication
3.	To know the various failure mechanism
4.	To understand the resistor layout and matching of resistors and capacitance.
5.	To know the assembling of die.

UNIT-I

Device Physics	**05 Hours**
Semiconductors, PN Junctions, Bi-Polar junction transistor, MOS Transistors, JFET transistors.	
Semiconductor Fabrication	**10 Hours**
Silicon Manufacture, photolithography, oxide growth and removal, diffusion and ion Implantation, Silicon deposition, Metallization, assembly. Polysilicon-Gate CMOS: Essential features,fabrication sequence,NMOS,PMOS transistors, substrate PNP transistors, Lightly doped drain transistors(LDD).	

UNIT-II

Analog Bi-CMOS	**08 Hours**
Essential features, Fabrication sequences, Available devices. **Failure mechanisms:** Electrical overstress, Contamination, Surface effects, Parasitic	
Resistors: Resistivity and sheet resistance, resistor layout, resisitor parasitic, capacitors. Matching of resistors and capacitors.	**07 Hours**

UNIT-III

Diodes and MOS transistors	**10 Hours**
Diodes in standard Bipolar, Diodes in CMOS and BiCMOS processes, Matching diodes. MOS Transistors: Modelling of MOS Transistors, Parasitic of MOS Transistors, self-aligned Poly-Gate CMOS Transistors. Application of MOS Transistors, Assembling the die: Die Planning, Floor Planning, Top-level Interconnection.	

Course Outcomes: At the end of the course student will be able to

1.	Describe basic operation and physical structures of semiconductor devices.	Use efficie
2.	Understand the Semiconductor fabrication process	Design hig precision a
3.	Describe essential features of analogue BiCMOS	Design anc
4.	Identify the device matching and isolation with respect to CMOS devices	Identify th performan
5.	Apply floor planning and power routing to design analog CMOS devices	Perform ca converters

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE4241-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4241-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE4241-1.3	2	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4241-1.4	2	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4241-1.5	3	-	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Alan Hastings, "The Art of Analog layout", Pearson; 2nd edition, 2004

REFERENCE BOOKS:

1. Ismail Franca, "Introduction to Analog VLSI Design Automation", Springer, 2011.
2. Randall Geiger, Noel Strader, Phillip Allen "VLSI Design Techniques for Analog", , 1st Edition, Mcgraw Hill Education, 2010
3. Gejji V.P, "Analog and Mixed Mode VLSI Design", Prentice Hall India Learning Private Limited 2011
4. R. Jacob Baker, "CMOS : Circuit Design, Layout And Simulation" , Wiley, 2009

HIGH SPEED DIGITAL DESIGN

Course Code:	**EE4242-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1002-2, EE3242-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand fundamental characteristics of the logic gates
2.	To know the limitation of measurement
3.	To understand the impact of power, speed and packaging in digital machine design
4.	To understand the functionality of ground and power planes

UNIT-I

Fundamentals: **04 Hours**

Frequency and Time, Time and Distance, lumped Vs distributed system, four kinds of reactance's

High speed properties of logic gates **05 Hours**

Power, Speed and Packaging

Measurement Techniques **06 Hours**

Rise time and bandwidth of Oscilloscope, self inductance of a probe ground loop, spurious signal pickup from ground loops, avoiding pickup from probe shield currents, viewing serial data transmission system, measuring operating margins.

UNIT-II

Transmission Lines **08 Hours**

Shortcomings of ordinary point to point wiring, infinite uniform transmission line, effects of source and load impedance, line impedance and propagation delay.

Ground Planes and Layer Stacking **07 Hours**

High speed current, cross talks, guard traces, near end and far end cross talks, how to stack printed circuit board layers.

UNIT-III

Termination **10 Hours**

End terminator, source terminators, AC biasing for end terminators, resistor selection, vias, power system.

Course Outcomes: At the end of the course student will be able to

1.	Describe the various relationships between frequency, time and distance
2.	Identify the high speed properties of logic gates and measurement techniques for digital system design.
3.	Analyze the effects of source and load impedance for high speed circuitry
4.	Identify the ground planes and layer stacking to control crosstalk between the signals
5.	Analyze the importance of terminators

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE4242-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-

EE4242-1.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
EE4242-1.3	2	2	-	-	-	-	-	-	-	-	-	1	2	-
EE4242-1.4	2	3	-	-	-	-	-	-	-	-	-	1	2	-
EE4242-1.5	3	-	-	-	-	-	-	-	-	-	-	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Howard W Johnson, Martin Graham, "High speed Digital design", A handbook of black magic, Prentice Hall, PTR, New Jersey,07632.

DIGITAL SYSTEMS DESIGN USING Verilog HDL

Course Code:	**EE3341-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**2:0:2:0**	**Credits**	**03**
Total Teaching Hours	**25+0+15**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1002-2**		

Teaching Department: Electrical & Electronics Engineering

**The course Semester End Exam will be similar to a Laboratory Course.*

Course Objectives:

1.	Understand various construct of Verilog HDL
2.	Familiarized with various levels of abstraction in Verilog.
3.	Comprehend the Verilog Tasks, Functions and Directives.
4.	Understand timing and delay Simulation.
5.	Know the process of logic synthesis and its impact in verification.

UNIT-I

Overview of Digital Design with Verilog HDL — **10 Hours**

Evolution of CAD, emergence of HDLs, typical HDL- flow, why Verilog HDL DL?, Trends in HDLs. Introduction to Verilog: Lexical Tokens ,Verilog operators and modules. Verilog ports, datatypes and assignments. Basic Gate level modelling.

UNIT-II

Basics of Gate level Modeling: — **08Hours**

Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. Different steps involved in the design of combinational circuits. Verilog modelling of Combinational circuits and sequential circuits.

Dataflow Modeling: — **07 Hours**

Basics of dataflow modelling ,Continuous assignments, concatenation, delay specification, expressions, operators, operands, operator types. Verilog modelling of Combination circuits.

UNIT-III

Behavioral Modeling: — **15 Hours**

Structured procedures, initial and always, blocking and non- blocking statements, delay control, generate statement, event control, conditional statements, multiway branching, loops, sequential and parallel blocks. Tasks and Functions: Differences between tasks and functions, declaration, invocation, automatic tasks and functions.

Useful Modeling Techniques: Procedural continuous assignments, overriding parameters, conditional compilation and execution, useful system tasks. Logic Synthesis with Verilog: Logic Synthesis, Impact of logic synthesis, Verilog HDL Synthesis, Synthesis design flow, Verification of Gate-Level Netlist.

Suggested List of experiments

Simulation:

1	Verilog program for combinational circuit design along with test bench to verify the design using gate level and data flow modelling
2	Verilog code for sequential logic circuit with test bench to verify the design using behavioural modeling
3	Design and verify Arithmetic Logic Unit

FPGA boards

1	Introduction to Xlinks and Spartan 6 FPGA board
2	Implement the functionality of Full adder and 4-Bit Comparator.
3	Implement the functionality of BCD to Seven-segment decoder
4	Implement the functionality of D flip flop ,JK flipflop and T flipflop.
5	Verilog code for 4-bit BCD synchronous counter
6	Interface DC motor with FPGA board
7	Design a clock divider circuit

Course Outcomes: At the end of the course student will be able to

1.	Learn the different Verilog HDL constructs.
2.	Familiarize the Gate level abstraction in Verilog.
3.	Understand Verilog Tasks, Functions and Directives.
4.	Understand timing and delay Simulation.
5.	Understand the concept of logic synthesis and its impact in verification.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3341-1.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
EE3341-1.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
EE3341-1.3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
EE3341-1.4	2	3	-	-	-	-	-	-	-	-	-	-	3	-
EE3341-1.5	2	3	-	-	-	-	-	-	-	-	-	-	3	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
2. Nazeih M. Botros, "HDL Programming (VHDL and Verilog)", Cengage Learning, 1st edition, 2011

REFERENCE BOOKS:

1. Donald E. Thomas, Philip R. Moorby, "The Verilog Hardware Description Language", SpringerScience + Business Media, LLC, Fifth edition.
2. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", Pearson (Prentice Hall), Second edition.
3. Padmanabhan, Tripura Sundari, "Design through Verilog HDL", Wiley, 2016 or earlier.

EMBEDDED SYSTEMS

Course Code:	**EE3342-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1002-2, EE2003-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To familiarize the concept of embedded system
2.	To identify various processing elements of embedded system and their structure
3.	To introduce various memory elements used in embedded systems
4.	To understand various interfacing devices used with embedded systems
5.	To introduce the concept of Real Time Operating Systems

UNIT-I

Introduction — **08 Hours**

Embedded systems overview-design challenge-optimizing metrics-processor technology-IC technology- design technology- automation- synthesis- verification: hardware /software co-simulation, trade-offs.

Processing Elements — **08 Hours**

Custom single purpose processor design-RT level custom single purpose processor design-optimizing custom single purpose processors -General purpose processor's software: architecture, operation, programmer's view and development environment – ASIPs - selecting a microprocessor - general purpose processor design

UNIT-II

Memory — **07 Hours**

Introduction-memory write-ability and storage permanence, common memory types-composing memory-memory hierarchy and caches, Cache mapping techniques advanced RAM

Interfacing — **09 Hours**

Introduction-communication basics-microprocessor interfacing: I/O addressing, interrupts, DMA-Arbitration- multilevel bus architectures-advanced communication principles-serial protocols-parallel protocols-wireless protocols-Standard single purpose processor's peripherals: timers, counters, watchdog timers, UART, PWM, LCD controllers, keypad controllers, stepper motor controllers, ADC and RTC.

UNIT-III

Introduction to Real-Time Operating Systems — **09 Hours**

Software architectures, Hard and soft real time systems, Basic functions of RTOS kernel, tasks and states, tasks and data, semaphores and shared data, Message Ques, Mailboxes and Pipes

Course Outcomes: At the end of the course student will be able to

1.	Describe the overview of embedded system to comprehend associated technologies
2.	Analyse various processing element in an embedded system to develop optimum design
3.	Identify the necessity of memory devices to comprehend use in embedded system
4.	Describe peripherals associated with embedded system to interface various modules
5.	Describe architecture of RTOS to comprehend functional capabilities of RTOS

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
EE3342-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3342-1.2	2	3	-	-	-	-	-	-	-	-	-	1	-	1
EE3342-1.3	2	3	-	-	-	-	-	-	-	-	-	1	-	1
EE3342-1.4	2	3	-	-	-	-	-	-	-	-	-	1	-	2
EE3342-1.5	2	3	-	-	1	-	-	-	-	-	-	1	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Frank Vahid and Tony Givargis, “Embedded system design: A unified hardware/Software introduction”, Third edition, John Wiley & sons, 2010
2. David E Simon, “Embedded System Premier”, Addison Wesley

REFERENCE BOOKS:

1. Raj Kamal , “Embedded System”, 2nd EditionTata McGraw-Hill Education
2. Wayne Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Morgan Kaufman Publishers, 2008.
3. Santanu Chattopadhyay, “Embedded system Design”, PHI Learning Pvt. Ltd., 2010
4. Steave Heath, “Embedded system Design”, Second edition, 2003
5. Daniel D. Gajski, Samar. Abdi, Andreas. Gerstlauer “Embedded system design: Modeling, synthesis and verification”, Springer, 2009
6. Jonathan.W.Valvano, “Embedded Microcomputer systems: Real Time Interfacing”, Third edition, Cengage learning,2012

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108102045

INTRODUCTION TO ASIC AND FPGA DESIGN

Course Code:	**EE3343-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1002-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the design flow of different types of ASIC
2.	To familiarize the different types of programming technologies and logic devices
3.	To learn the architecture of different types of FPGA
4.	To understand partitioning, floor planning, placement and routing including circuit extraction of ASIC
5.	To analyse the synthesis, Simulation and testing of digital systems.
6.	To understand the importance and applications of SOC.

UNIT-I

OVERVIEW OF ASIC AND PLD — **08 Hours**

Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices : ROMs and EPROMs – PLA–PAL. Gate Arrays – CPLDs and FPGAs

ASIC PHYSICAL DESIGN — **07 Hours**

System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning -placement – Routing : global routing - detailed routing - special routing - circuit extraction – DRC

UNIT-II

LOGIC SYNTHESIS, SIMULATION AND TESTING — **08 Hours**

Design systems - Logic Synthesis - Half gate ASIC -schematic entry - low level design language - PLA tools -EDIF- CFIdesign representation. Verilog and logic synthesis -VHDL and logic synthesis - types of simulation -boundary scan test – fault simulation - automatic test pattern generation.

FPGA — **08 Hours**

Logic blocks, routing architecture, design flow technology - mapping for FPGAs, XilinxXC4000 - ALTERA’s FLEX 8000/10000, ACTEL’s ACT-1,2,3 and their speed performance Case studies: Altera MAX 5000 and 7000 - Altera MAX 9000 – Spartan II and Virtex II FPGAs - Apex and Cyclone FPGAs.

UNIT-III

SOC DESIGN — **09 Hours**

Design methodologies – Processes and flows - Embedded software development for SOC – Techniques for SOC testing –configurable SOC – hardware / software codesign Case studies: Digital camera, Bluetooth radio / modem, SDRAM and USB.

Course Outcomes: At the end of the course student will be able to

1.	Describe the design flow to identify different types of ASIC
2.	Apply different types of programming techniques to design logic devices
3.	Apply logic synthesis, simulation and testing to design digital systems
4.	Analyse various manufacturer FPGA to write program for given application
5.	Describe embedded software development to design applications of SOC.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3343-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3343-1.2	1	3	-	-	1	-	-	-	-	-	-	1	-	-
EE3343-1.3	1	3	-	-	2	-	-	-	-	-	-	1	-	-
EE3343-1.4	2	2	1	3	2	-	-	-	-	-	-	2	-	-
EE3343-1.5	2	3	-	-	1	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. M.J.S .Smith, "Application Specific Integrated Circuits, Addison -Wesley Longman Inc.,1997
2. S. Trimberger, "Field Programmable Gate Array Technology", Edr, Kluwer Academic Publications, 1994.

REFERENCE BOOKS:

1. John V.Oldfield, Richard C Dore, "Field Programmable Gate Arrays", Wiley Publications1995.
2. P.K.Chan & S. Mourad, "Digital Design Using Field Programmable Gate Array", PrenticeHall, 1994.
3. Parag.K.Lala, "Digital System Design using Programmable Logic Devices" , BSP, 2003

E Books / MOOCs/ NPTEL

1. https://www.nptelvideos.com/course.php?id=545

LINEAR INTEGRATED CIRCUITS AND ITS APPLICATIONS

Course Code:	**EE3344-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1, EE2101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the basics of op-amp and demonstrate the use of Op-Amp in signal processing applications
2.	To analyze the non-linear behavior of the Op-Amp and design Op-Amp circuits in open loop and with positive feedback.
3.	To understand the applications of op-amp and 555 timers for waveform generation
4.	To design active filters, A/D, D/A converters and voltage regulator using op-amp

UNIT-I

Op-Amp Fundamentals	**05 Hours**

(Brief review of differential amplifier, current mirror, active load, level shifter, output stage; ac and dc characteristics).Basic building blocks using Op-Amps. Inverting/Non-inverting VCVS, Integrators, Differentiators, CCVS and VCCS, Instrumentation Amplifiers

Op-Amp Signal Processing Circuits	**05 Hours**

Precision Half wave and full wave rectifiers, limiting circuits, clamping circuits, peak detectors, sample and hold circuits.

Op-Amp Nonlinear Circuits	**05 Hours**

Op-Amps in switching circuits, crossing detectors, inverting Schmitt trigger circuits, non-inverting circuits, Astable multivibrators, Monostable multivibrators, Op-Amp based SCR triggering circuit.

UNIT-II

Waveform generators	**06 Hours**

Phase Shift Oscillators, Colpitts Oscillators, Hartley Oscillator,
555 TIMER - Monostable and Astable multivibrators and applications,
Ramp Generator: Triangle generator, Sawtooth generator Sine wave generator: Requirement for sinusoidal oscillations, Wien-bridge and twin-T oscillators.

Digitally controlled frequency synthesizer	**04 Hours**

PLL Fundamentals, PLL synthesizer, Totally digital synthesizer

Active Filters	**05Hours**

First and Second order high pass and low pass filters. Band pass filter, Band stop filters. Higher order filters. State variable filter, Universal active filter

UNIT-III

D to A and A to D Converters	**05 Hours**

Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

Voltage Regulators	**05 Hours**

Op-Amp Regulators, precision voltage regulator IC Regulators, Fixed Voltage Regulators (78/79, XX), SMPS.

Course Outcomes: At the end of the course student will be able to

1.	Analyze the basic building blocks of Op-Amp and signal processing circuits
2.	Analyze the non-linear behavior of Op-Amp to design signal processing circuits
3.	Design various waveform generator using op-amp and 555 times
4.	Analyze the principles of PLL and design active filters
5.	Analyze the D/A and A/D converters and design voltage regulators using op-amp

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3344-1.1	2	2	3	-	2	-	-	-	-	-	-	-	1	2
EE3344-1.2	2	2	3	-	2	-	-	-	-	-	-	-	2	2
EE3344-1.3	2	2	3	-	2	-	-	-	-	-	-	-	2	2
EE3344-1.4	2	2	2	3	2	-	-	-	-	-	-	-		2
EE3344-1.5	2	2	3	-	2	-	-	-	-	-	-	-	3	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	David A Bell, "Operational Amplifier and Linear IC's", Oxford University Press-New Delhi, 3rd Edition, 2011.
2.	Sedra and Smith, "Microelectronic Circuits", Oxford University press, 5th Edition, 2005.
3.	Ramakanth Gayakwad, "Operational Amplifiers and Linear IC's", 4th edition — Prentice Hall, 2000.

REFERENCE BOOKS:

1.	Roy Choudhry, "Operational amplifiers and Linear Integrated circuits", New Age International,4th edition, April 2011.
2.	Stanley William D., "Operational amplifiers and Linear Integrated circuits ", 4th Edition, Pearson Education.2001.
3.	Sergio Franco (1997), "Design with operational amplifiers and analog integrated circuits", McGraw Hill, New Delhi.

E Books / MOOCs/ NPTEL

1.	TI Precision Labs - Op Amps
2.	NPTEL course on Op-Amp Practical Applications: Design, Simulation and Implementation by Prof. Hardik Jeetendra Pandya, IISc Bangalore
3.	Linear Integrated Circuits UC Berkeley, Spring 2014 , Prof. Clark Tu-Cuong Nguyen, http://freevideolectures.com

Professional Elective Courses (Electric Vehicle Stream)

AUTOMOTIVE ELECTRONICS

Course Code:	**EE2251-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME1004-1, EE2002-1, EE3002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Understand various aspects of electronic system in vehicle control
2.	Familiarized with various sensors used in vehicle control.
3.	Comprehend the communication protocol used in vehicle.
4.	Understand concepts of AUTOSAR.
5.	Know the data processing and memory management system.

UNIT-I

Electrical and Electronic Systems in the Vehicle: **07 Hours**

Overview, Motoronic-engine management system, Electronic diesel control, Lighting technology, electronic stability program, adaptive cruise control, Infotainment System.

Automotive Sensors & Measuring Principle: **08 Hours**

Air Flow Rate Sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall-Effect Position Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor, Temperature Sensors, Exhaust Gas Oxygen Sensor, Knock Sensors, Automotive Engine Control Actuators.

UNIT-II

In Vehicle Networking: **08 Hours**

Need for In-vehicle Networking, Vehicle buses. Overview of CAN, LIN, Flex Ray, MOST protocols. Vehicular ad hoc networks (VANETs).

AUTOSAR Concepts: **07 Hours**

Architecture, Methodology and Application Interfaces. ECU SW Architecture, Virtual Function Bus, Abstraction Layer, BSW, RTE, ECU Communication

UNIT-III

Architecture of Electronic Systems & Control Units: **10 Hours**

Basics and Overview, vehicle system architecture. Control units, Operating conditions, Design and data processing. Digital modules in the control unit. Automotive Applications.

Course Outcomes: At the end of the course student will be able to

1.	Describe the function and operation of Automotive Electrical and Electronic subsystems
2.	Discus the principle and operation of sensors and actuators used in automotive applications.
3.	Analyse the use of CAN, LIN, MOST and Flexray protocols in automotive applications.
4.	Explain the architecture & Methodology of AUTOSAR.
5.	Describe automotive data processing and memory system

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2251-1.1	2	-	-	-	-	-	-	-	-	-	-	1	3	
EE2251-1.2	2	1	1	-	-	-	-	-	3	3	1	1	3	2
EE2251-1.3	1	1	1	-	-	-	-	-	3	3	1	1	3	2

EE2251-1.4	1	-	-	-	-	-	-	-	-	1	-	1	3	-
EE2251-1.5	2	-	1	-	-	-	-	-	3	3	1	1	3	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Robert Bosch GmbH, "Bosch Automotive Electrics and Automotive Electronics", 5th Edition. John Wiley & Sons Ltd, 2007
2. William B. Ribbens "Understanding Automotive Electronics", 6th Edition, Elsevier, 2003
3. Tom Denton, "Automobile Electrical and Electronic Systems", 3rd Edition, Elsevier Butterworth-Heinemann Publication, 2004.
4. KPIT Technologies Ltd. "KPIT-AUTOSAR Handbook", https://www.kpit.com/resources/downloads/kpit-autosar-handbook.pdf

REFERENCE BOOKS:

1. Nicolas Navet and Françoise Simonot-Lion, "Automotive Embedded Systems Handbook", CRC Press, 2009.

HYBRID ELECTRIC VEHICLES

Course Code:	**EE2252-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME1003-1, EE3101-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the fundamentals of electric and hybrid electric vehicles, EV policies, standards and EV architecture..
2.	To understand control strategies and design principles of series hybrid vehicle drive train.
3.	To know the design principles & control strategy of parallel and series-parallel hybrid drive train
4.	To study the control principles of plug-in hybrid electric vehicles
5.	To understand fundamentals of regenerative breaking and CAN fundamentals

UNIT-I

Electric Vehicles	**06 Hours**
Configurations of electric vehicles (EVs), Performance of EVs, Tractive Effort in Normal Driving, Energy Consumption. EV Policies & Standards	
Hybrid Electric Vehicles	**08 Hours**
Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains	

UNIT-II

Design Principle of Series (Electrical Coupling) Hybrid Electric Drive Train	**10 Hours**
Operation Patterns, Control Strategies, Design Principles of a Series (Electrical Coupling) Hybrid Drive Train, Design Example	
Parallel (Mechanically Coupled) Hybrid Electric Drive Train Design	**06 Hours**
Drive Train Configuration and Design Objectives, Control Strategies, Parametric Design of a Drive Train	

UNIT-III

Design and Control Methodology of Series–Parallel (Torque and Speed Coupling) Hybrid Drive Train	**04 Hours**
Drive Train Configuration, Drive Train Control Methodology, Drive Train Parameters Design	
Design and Control Principles of Plug-In Hybrid Electric Vehicles	**04 Hours**
Statistics of Daily Driving Distance, Energy Management Strategy, Energy Storage Design.	
CAN Communication	**02 Hours**
CAN Fundamentals, CAN message frames, Typical Automotive Networks,	

Course Outcomes: At the end of the course student will be able to

1.	Describe the fundamentals of electric and hybrid electric vehicles to understand EV architecture.
2.	Analyze control strategies to design of hybrid vehicle drive train.
3.	Analyze control methodology and design of series-parallel hybrid drive train.

4.	Describe the control principles of plug-in hybrid electric vehicles to predict the energy requirements.
5.	Describe CAN communication and fundamentals of regenerative breaking to compare the energy management strategies.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2252-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2252-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE2252-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE2252-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	2
EE2252-1.5	3	-	-	-	-	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2010.

REFERENCE BOOKS:

1. Tom Denton, "Electric and Hybrid Electric Vehicles", second edition, Institute of motor Industry, 2nd edition, 2020.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108106170

ENERGY STORAGE & BATTERY MANAGEMENT SYSTEMS

Course Code:	**EE3251-1**	**Course Type:**	**PEC**
Teaching Hours/Week (L: T: P:S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**ME1003-1, EE3101-1,**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the selection of batteries for Electric vehicle.
2.	To model energy storage system
3.	To familiarize various concepts of BMS
4.	To understand functional blocks of BMS
5.	To study design steps of BMS
6.	To introduce hardware implementation of BMS

UNIT-I

Energy storage for EV and HEV — **08 Hours**

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.

Parameter Estimation of Energy Storage System — **07 Hours**

Methods of Determining the State of Charge, Estimation of Battery Power Availability, Battery Life Prediction, Cell Balancing, Estimation of Cell Core Temperature, Battery System Efficiency

UNIT-II

BMS Options — **07 Hours**

Functionality, CCCV Chargers, Regulators, Meters, Monitors, Balancers, Protectors, Functionality Comparison, Technology, Simple (Analog), Sophisticated (Digital), Technology Comparison, Topology, Centralized, Modular Master-Slave, Distributed, Topology Comparison

BMS Functions — **08 Hours**

Measurement, Voltage, Temperature, Current, Management, Protection, Thermal Management, Balancing, Redistribution, Distributed Charging, Evaluation, State of Charge and Depth of Discharge, Capacity, Resistance, State of Health (SOH), External Communications, Dedicated Analog Wire, Dedicated Digital Wire, Data Link, Logging and Telemetry, Off-the-Shelf BMSs, Cell Manufacturers' BMSs, Comparison

UNIT-III

Deploying a BMS — **10 Hours**

Brief overview of analog and digital BMS design, Installing, Battery Pack Design, BMS Connections to Pack, BMS Connections to System, Configuring, Cell Configuration, Pack Configuration, System Configuration, Testing, Troubleshooting, Grounding, Shielding, Filtering, Wire Routing

Course Outcomes: At the end of the course student will be able to

1.	Explore concepts and selection of storage devices for electric vehicles.
2.	Model and estimate parameter of energy storage system.
3.	Identify process to implement BMS
4.	Illustrate functionality of BMS
5.	Analyze the hardware implementation aspects of BMS

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3251-1.1	1	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3251-1.2	1	3	-	-	-	-	-	-	-	-	-	-	1	-
EE3251-1.3	1	2	3	-	-	-	-	-	-	-	-	-	1	-
EE3251-1.4	1	2	2	3	-	-	-	-	-	-	-	-	-	1
EE3251-1.5	1	3	-	-	-	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Sandeep Dhameja, "Electric vehicle battery systems", Newnes Publishing, 2002
2. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs", ARTECH HOUSE 2010.

REFERENCE BOOKS:

1. Rui Xiong, "Battery Management Algorithm for Electric Vehicles", Springer 2019
2. Nicolae Tudoroiu, "Battery Management Systems of Electric and Hybrid Electric Vehicles", MDPI 2021

POWER ELECTRONICS & DRIVES FOR ELECTRIC VEHICLES

Course Code:	**EE3252-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3101-1,**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To explain the principles of power electronics converters used in HEVs
2.	To understand the concept of battery chargers and thermal management of HEV power converters.
3.	To study various electric drives used in EVs and their control
4.	To analyze design and modeling of traction motors.
5.	To introduce vehicular power control strategy & energy management.

UNIT-I

Power Electronics in HEVs	**07 Hours**

Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC-DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC-DC Converter, ,

DC–DC Converters Applied in Hybrid Electric Vehicle	**08 Hours**

PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics

UNIT-II

Electric Drives and Control in HEVs	**15 Hours**

Introduction, Induction Motor Drives, and Control, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, BLDC Motor and Control, Design and Sizing of Traction Motors, Thermal Analysis and Modeling of Traction Motors

UNIT-III

Vehicular Power Control Strategy and Energy Management	**10 Hours**

Modeling and Simulation of HEV Power Electronics

Course Outcomes: At the end of the course student will be able to

1.	Analyze various power electronics converters used in HEVs.
2.	Describe various converters for EV battery charging, emerging power electronics devices and thermal management.
3.	Analyze the operation and control of various electric drives used in HEVs.
4.	Select, design, model and perform thermal analysis of traction motors.
5.	Analyze vehicular power control strategy to model & simulate HEV power converters

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3252-1.1	1	3	-	-	-	-	-	-	-	-	-	-	-	-

EE3252-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3252-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3252-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3252-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Chris Mi, M. Abul Masrur, "Hybrid Electric Vehicles-Principles and Applications With Practical Perspectives", Wiley, 2011

REFERENCE BOOKS:

1. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, Wiley,2017

E Books / MOOCs/ NPTEL

1. https://www.coursera.org/certificates/power-electronics-motors-ev-iitbombay

THERMAL MANAGEMENT OF EV SYSTEMS

Course Code:	**EE3253-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study semiconductor technology and the importance of thermal management
2.	To understand and derive equivalent thermal resistance network
3.	To explain temperature distribution in the fin and heat transfer rate
4.	To comprehend advanced cooling technologies in electronic equipment
5.	To describe importance and specifications of microelectronics packages

UNIT-I

Introduction to thermal management of Electronics	**05 Hours**
Semiconductor Technology Trends, Temperature Dependent Electrical Failures, Importance of Heat Transfer in Electronics, Thermal Design Process	
Thermal Resistance Network	**10 Hours**
Thermal Resistance Concept, Series Thermal Layers, Parallel Thermal Layers, General Resistance Network, Thermal Contact Resistance, Interface Materials, Spreading Thermal Resistance, Thermal Resistance of Printed Circuit Boards (PCBs)	

UNIT-II

Fins and Heat Sinks	**07 Hours**
Fin Equation; Fin Thermal Resistance, Effectiveness and Efficiency; Fins with Variable Cross Sections; Heat Sink Thermal Resistance, Effectiveness, and Efficiency; Heat Sink Manufacturing Processes	
Advanced Cooling Technologies	**08 Hours**
Heat Pipes- Capillary Limit, Boiling Limit, Sonic Limit, Entrainment Limit, Other Heat Pipe Performance Limits, Heat Pipe Applications in Electronic Cooling, Heat Pipe Selection and Modeling, Thermosyphons, Liquid Cooling	

UNIT-III

Thermal Specification of Microelectronic Packages	**10 Hours**
Importance of Packaging, Packaging Types, Specifications of Microelectronic Packages- Junction-to-Air Thermal Resistance, Junction-to-Case and Junction-to-Board Thermal Resistances, Parameters Affecting Thermal Characteristics of a Package	

Course Outcomes: At the end of the course student will be able to

1.	Understand the possible failures and the importance of efficient heat transfer techniques to modify the design to cool a system
2.	Develop equivalent thermal resistance network to calculate the heat transfer rate
3.	Compute temperature distribution in the fin and heat transfer rate to reduce heat dissipation
4.	Describe the different techniques used for cooling electronic equipment
5.	Calculate thermal resistance of different electronic packages to calculate maximum allowable junction temperature

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE3253-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE3253-1.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE3253-1.3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE3253-1.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE3253-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Younes Shabany,"Heat Transfer: Thermal Management of Electronics" 2010 , CRC Press.

REFERENCE BOOKS:

1. Jerry Sergent, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, Mc Graw- Hill.
2. "Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013, Coventry Techno centre, UK
3. T. Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAE International.

AUTOMOTIVE SECURITY

Course Code:	**EE2351-1**	**Course Type:**	**PEC**
Teaching Hours/Week (L: T: P:S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the methods of cryptography
2.	To know the importance of embedded security
3.	To understand the network security issues in automotive network
4.	To understand the requirement of firmware resiliency in automotive application.

UNIT-I

Cryptography Introduction	**07 Hours**

Introduction to cryptography, Classical Cryptosystem, Block Cipher Data Encryption Standard (DES), Triple DES, Modes of Operation, Stream Cipher. Advanced Encryption Standard (AES), Introduction to Public Key Cryptosystem, Diffie-Hellman Key Exchange, Knapsack Cryptosystem, RSA Cryptosystem.

Protecting IP in cloud connected world	**07 Hours**

Protection of IP, CODE isolation, encryption, hardware security, trustonic expertise tool for IP protection.

UNIT-II

Embedded Security: Introduction	**08 Hours**

Authentication, Integrity and Confidentiality, Properties of secure system Security elements(JIL), importance of keys in security, customization challenges, distribution of keys, tools and examples.(cryptoAuthlib)

Automotive Network security	**08 Hours**

Motivation for automotive network security, Automotive security, message authentication, Automotive security IC attributes, security challenges.

UNIT-III

Firmware Resiliency in Automotive application	**10 Hours**

Automotive growth drivers, Firmware Vulnerabilities in automotive, Simplified protection, Automotive Platform firmware protection (secure boot controller).
Firmware Vulnerabilities in data centre.

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the algorithms of cryptography for data and network security
2.	Explain the importance of Protection of IP in cloud connected network
3.	Analyze the importance of key security and customization challenges for embedded security
4.	Describe the importance of message authentication and security challenges and solutions for automotive network.
5.	Analyze the importance of firmware resiliency in automotive applications.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
													1	2
EE2351-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE2351-1.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE2351-1.3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE2351-1.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE2351-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Wiiliam Stallings, “Cryptography and Network security Principles and practices ”, 4th Edition, prentice hall, November 16,2015.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs16/preview
2. https://www.microchip.com/en-us/solutions/embedded-security
3. https://vimeo.com/371395354

BATTERY STORAGE AND FUEL CELLS FOR ELECTRIC VEHICLES

Course Code:	**EE2352-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CY1005-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand working of various energy storage devices
2.	To introduce the concept of fuel cells
3.	To analyze fuel cell hybrid electric drive train design
4.	To compare various energy storage systems and modeling
5.	To discuss battery charge control and management

UNIT-I

Peaking Power Sources and Energy Storages	**09 Hours**
Electrochemical Batteries, Ultracapacitors, Ultra-High-Speed Flywheels, Hybridization of Energy Storages	
Battery Characterization	**07 Hours**
Comparison of Different Energy Storage Technologies for HEVs, Modeling Based on Equivalent Electric Circuits	

UNIT-II

Fuel cells	**06Hours**
Operating Principles of Fuel Cells, Electrode Potential and Current–Voltage Curve, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, Fuel Cell Technologies, Fuel Supply, Non-Hydrogen Fuel Cells	
Fuel Cell Hybrid Electric Drive Train Design	**08 Hours**
Configuration, Control Strategy, Parametric Design, Motor Power Design, Power Design of the Fuel Cell System, Design of the Power and Energy Capacity of the PPS, Design Example	

UNIT-III

Battery charge management	**10 Hours**
Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System modeling.	

Course Outcomes: At the end of the course student will be able to

1.	Describe various energy storage technologies used in EVs
2.	Analyze the various energy storage technologies for HEV
3.	Analyze the characteristics of fuel cells
4.	Analyze the design of Hybrid Electric Vehicle using fuel cells
5.	Analyze battery charge control and charge management of storage devices.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE2352-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2352-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE2352-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE2352-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE2352-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2010.
2. Chris Mi, M. Abul Masrur, "Hybrid Electric Vehicles-Principles and Applications With Practical Perspectives", Wiley, 2011

REFERENCE BOOKS:

1. Tom Denton, "Electric and Hybrid Electric Vehicles", second edition, Institute of motor Industry, 2nd edition, 2020.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108103009

ELECTRIC VEHICLE BATTERY CHARGING TECHNIQUES

Course Code:	**EE3351-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CY1005-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand fundamentals and selection of storage devices for electric vehicles
2.	To study the electric vehicle battery parameters and analyze effect on battery efficiency
3.	To explain electric vehicle battery charging technologies
4.	To understand electric vehicle battery discharging behavior.
5.	To understand electric vehicle battery performance and thermal management.

UNIT-I

Electric Vehicle Batteries	**03 Hours**

Electric Vehicle Operation, Battery Basics, Introduction to Electric Vehicle Batteries, Fuel Cell Technology, Choice of a Battery Type for Electric Vehicles

Electric Vehicle Battery Efficiency	**06 Hours**

Effects of VRLA Battery Formation on Electric Vehicle Performance, Regenerative Braking, Electric Vehicle Body and Frame, Fluids, Lubricants, and Coolants, Effects of Current Density on Battery Formation, Effects of Excessive Heat on Battery Cycle Life, Battery Storage, The Lithium-ion Battery, Traction Battery Pack Design

Electric Vehicle Battery Capacity	**06 Hours**

Battery Capacity, The Temperature Dependence of Battery Capacity, State of Charge of a VRLA Battery, Capacity Discharge Testing of VRLA Batteries, Battery Capacity Recovery, Definition of NiMH Battery Capacity, Li-ion Battery Capacity, Battery Capacity Tests, Energy Balances for the Electric Vehicle

UNIT-II

Electric Vehicle Battery Charging	**05 Hours**

Charging a Single VRLA Battery, Charge Completion of a Single VRLA Battery, Temperature Compensation During Battery Charging, Charging NiMH Batteries, Rate of Charge Effect on Charge Acceptance Efficiency of Traction, Battery Packs, Environmental Influences on Charging, Charging Methods for NiMH Batteries, Charging Technology, Battery Pack Corrective Actions

Electric Vehicle Battery Fast Charging: On-board & off-board charging	**05 Hours**

Fast Charging Process, Fast Charging Strategies, The Fast Charger Configuration, Using Equalizing/Leveling Chargers, Inductive Charging—Making Recharging Easier, Range Testing of Electric Vehicles Using Fast Charging, Electric Vehicle Speedometer Calibration. Wireless Charging.

Electric Vehicle Battery Discharging	**05 Hours**

Definition of VRLA Battery Capacity, Definition of NiMH Battery Capacity, Discharge Capacity Behavior, Discharge Characteristics of Li-ion Battery, Discharge of an Electric Vehicle Battery Pack, Cold-Weather Impact on Electric Vehicle Battery Discharge

UNIT-III

Electric Vehicle Battery Performance	**10 Hours**
The Battery Performance Management System, BPMS Thermal Management System, The BPMS Charging Control, High-Voltage Cabling and Disconnects, Safety in Battery Design, Battery Pack Safety—Electrolyte Spillage and Electric Shock, Charging Technology, Electrical Insulation Breakdown Detection, Electrical Vehicle Component Tests, Building Standards, Ventilation	

Course Outcomes: At the end of the course student will be able to

1.	Explore concepts and selection of storage devices for electric vehicles.
2.	Analyze the electric vehicle battery parameters and battery efficiency.
3.	Explore electric vehicle battery charging technologies
4.	Analyze electric vehicle battery discharging behavior.
5.	Analyze electric vehicle battery performance and thermal management.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3351-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3351-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3351-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3351-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3351-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Sandeep Dhameja, "Electric vehicle battery systems", Newnes Publishing, 2002

REFERENCE BOOKS:

1. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, Wiley,2017

MODELING AND CONTROL OF HYBRID ELECTRIC VEHICLES

Course Code:	**EE3352-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To model hybrid electric vehicle system components
2.	To model energy storage system
3.	To study hybrid electric vehicle vibration, noise & control
4.	To analyze the performance of HEVs

UNIT-I

Modeling of Hybrid Electric Vehicle	**15 Hours**

Modeling of an Internal Combustion Engine, Modeling of an Electric Motor, Modeling of the Battery System, Modeling of the Transmission System, Modeling of a Multi-mode Electrically Variable Transmission, Lever Analogy as a Tool for ECVT Kinematic Analysis, Modeling of the Vehicle Body, Modeling of the Final Drive and Wheel, PID-based Driver Model

UNIT-II

Modeling and Parameter Estimation of Energy Storage System	**08 Hours**

Electrical equivalent model of energy storage system, Methods of Determining the State of Charge, Estimation of Battery Power Availability, Battery Life Prediction, Cell Balancing, Estimation of Cell Core Temperature, Battery System Efficiency

Hybrid Electric Vehicle Vibration, Noise, and Control	**07 Hours**

Basics of Noise and Vibration, General Description of Noise, Vibration, and Control in Hybrid Electric Vehicles

UNIT-III

Performance Analysis of Hybrid Electric Vehicle	**10 Hours**

Hybrid Electric Vehicle Simulation System, Typical Test Driving Cycles, Sizing Components and Vehicle Performance Analysis, Fuel Economy, Emissions, and Electric Mileage Calculation

Course Outcomes: At the end of the course student will be able to

1.	Analyze and model mechanical components of hybrid electric vehicle system.
2.	Analyze and model electrical components of hybrid electric vehicle system.
3.	Model and estimate parameter of energy storage system.
4.	Analyze and control hybrid electric vehicle vibration & noise.
5.	Analyze performance of HEV and HEV simulate system.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3352-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3352-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3352-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3352-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	1
EE3352-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, Wiley, 2017

E Books / MOOCs/ NPTEL

1. https://archive.nptel.ac.in/courses/108/103/108103009/

VEHICLE MANAGEMENT AND CONTROL

Course Code:	**EE3353-1**	**Course Type:**	**PEC**
Teaching Hours/Week (L: T: P:S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the basic control systems in power train
2.	To recognize the electronically controlled system
3.	To understand the body electronics and lighting in electrical vehicle
4.	To identify the motor and control systems in EV
5.	To know the requirement for infotainment and display

UNIT-I

EV,HEV and Power Train	**08 Hours**
1 phase and 3 phase AC analog control, 1 phase and 3 phase AC digital control, battery pack passive balancing, DC-DC converter, automatic transmission, Battery control unit, DC fast charging, drive line components, electric power steering, fuel cell control unit, sensors in power train, Block diagram of VCU, Virtual engine sound system.	
Advanced driver assistant systems(ADAS)	**07 Hours**
ADAS domain controller, automotive thermal camera, camera module without processing, conditionally automated drive controller, drive assist ECU, Drive monitoring, LiDAR.	

UNIT-II

Body Electronics and Lighting	**08Hours**
Automotive HVAC compressor Module, Automotive HVAC control module, Automotive HVAC sensors, Automotive gateway, heater module, Body control module, DC/AC inverter, door handle module, gesturing, headlight, Interior Light, Obstacle detection sensor, power distribution box, rear light, wiper module, sliding door module, smart glass module, seat comfort module, passive entry passive start.	
Motor control and Drive	**07Hours**
Motor types: ACIM control, Brushed DC motor Control, PMSM control, Stepper Motor control, Switched reluctance Motor control.	

UNIT-III

Infotainment and cluster	**04 Hours**
Head unit, audio amplifiers, telematics, USB media Hub, wireless charging	
Display	**04 Hours**
Graphical user interface, Human machine interface for diagnostic tools	
Timing and Synchronization	**02 Hours**
Navigation, secure position and synchronization	

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the basics of power train modules in EV and HEV
2.	Recognize the electronically controlled system used in advanced driver assistance system
3.	Identify the body electronics and lighting requirement for EV
4.	Select the type of motors and control system for EV application
5.	Recognize the need of infotainment, display and synchronization for effective automated transport system.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE3353-1.1	2	3	-	-	3	-	-	-	-	-	-	-	3	3
EE3353-1.2	2	3	-	-	3	-	-	-	-	-	-	-	3	3
EE3353-1.3	2	3	-	-	3	-	-	-	-	-	-	-	3	3
EE3353-1.4	2	3	-	-	3	-	-	-	-	-	-	-	3	3
EE3353-1.5	2	3	-	-	3	-	-	-	-	-	-	-	3	3

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. https://www.microchip.com/en-us/solutions
2. https://www.ti.com/applications/automotive/overview.html
3. Bosch Automotive Handbook, Sixth edition,2004.

Professional Elective Courses (IT Stream)

DATABASE MANAGEMENT SYSTEMS

Course Code:	**EE2261-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives: This course will enable students to

1.	Describe databases and database management systems
2.	Understand database structures and their working principles.
3.	Design simple database models using Entity-Relationship Modeling
4.	Learn how to relate tables together in a database
5.	Recognize structured query language (SQL) statements and write queries using SQL
6.	Construct the stages of database project design-query processing and optimizing database, concurrency control using locking techniques
7.	Understand the issues associated with Transaction Processing and Recovery

UNIT-I

Introduction:	**06 Hours**
DBMS Administrators, Designers, Users, Developers & maintenance users of DBMS.	
DBMS	**07 Hours**
Architecture, Schemes & Interfaces. Entity-Relationship model, Record storage & primary file organization: Hashing techniques, Index structures, Multilevel indexes using B-trees.	
Relational data model & Relational algebra	**03 Hours**
Queries in relational algebra	

UNIT-II

SQL	**07 Hours**
A Relational Database language, Different clauses & example queries.	
Database Design	**07 Hours**
I, II, III Normal forms, BCNF, Join dependencies, IV & V Normal forms.	

UNIT-III

Processing and optimization	**10 Hours**
Query processing & Optimization, Transactions, Recovery & Concurrency control. Security & Integrity constraints.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the working principle of a database structure.
2.	Construct a simple database model using Entity- Relationship Modeling
3.	Develop the queries using SQL to retrieve data from database.
4.	Describe the stages of database project design considering the normal forms of database design.
5.	Describe the stages of database project design considering the normal forms of database design.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2
EE2261-1.1	3	-	-	-	-	-	-	-	2	-	-	-	1	-
EE2261-1.2	3	1	-	-	-	-	-	-	2	-	-	-	1	-
EE2261-1.3	3	2	-	-	-	-	-	-	2	-	-	-	1	-
EE2261-1.4	3	-	-	-	-	-	-	-	2	-	-	-	1	-
EE2261-1.5	3	-	-	-	-	-	-	-	2	-	-	-	1	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", The Benzamin/Cummings, Addison-Wesley, VI Edition, 2011.

OBJECT ORIENTED PROGRAMMING USING C++

Course Code:	**EE2262-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the concept of Object Oriented programming and its realization in C++.
2.	To discuss the concept of functions and classes.
3.	To illustrate the concepts of objects constructors and destructors
4.	To understand the meaning of operator overloading type conversion and inheritance.

UNIT-I

Principles of Object-Oriented Programming	**03 Hours**
Review of Procedure Oriented Programming, Basic concepts of Object Oriented Programming – Object, Class, Encapsulation, Inheritance, Polymorphism; Benefits of OOPs, Applications of OOP's	
The Basic Language C++	**05 Hours**
A comparison of C and C++, Structure of C++ program with Class, Preprocessor directives, C++ Statements – Input/Output, Comments, Tokens, Keywords, Identifiers, Constants, Data types – string, pointer, reference, Boolean, enumeration, array, complex number; typedef names, type compatibility, type conversion, qualifier – const, volatile; Operators in C++, Operator Precedence; C++ expressions – New and Delete.	
Functions and Classes	**07 Hours**
Introduction, The main function, Function prototype, Call by reference, Return by reference, Inline functions, Default arguments, const Arguments, Function Overloading. Introduction – declaration and definition of a Class, defining member functions, C++ program with a Class, Making an outside function Inline, Nesting of member functions, Arrays within a class, Static data members, static member functions.	

UNIT-II

Objects	**04 Hours**
Global & local objects, scope & lifetime, memory allocation for objects, dynamically allocated objects, pointers to objects, arrays of objects, function arguments with objects, returning objects; const member functions, pointer to members	
Constructors and Destructors	**04 Hours**
Introduction, Constructors, Parameterized Constructors, Multiple constructors in a class, Constructors with default arguments, Dynamic initialization of objects, Copy constructor, Constructing two-dimensional arrays, const Objects, Destructors.	
Operator Overloading and Type Conversion	**05 Hours**
Introduction, Defining operator overloading, Overloading unary operators, Overloading binary operators, Overloading binary operators using Friends, Rules for overloading operators, overloading a comma operator, overloading the output operator, Type conversion	

Inheritance	**03 Hours**
Introduction, defining derived classes, Single inheritance, Making a private member Inheritable, Multilevel inheritance, Multiple inheritances, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes.	
UNIT-III	
Pointer, Virtual Functions, and Polymorphism	**04 Hours**
Introduction, Pointers, Pointers to Objects, this pointer, Pointers to derived classes, type-checking pointers, pointers to members, Virtual functions, Pure virtual functions.	
Managing Console I/O and File I/O	**05 Hours**
C++ streams, C++ stream classes, examples of formatted and unformatted I/O operations, Classes for file stream operations, Methods of Opening and Closing a File, Examples of Opening file using constructor open, file modes (simple programming exercises).	

Course Outcomes: At the end of the course student will be able to

1.	Describe the concept of Object-Oriented Programming and basics of C++ to compare C with C++
2.	Apply functions and classes to develop simple programs
3.	Apply the concept of constructors to dynamically initialize objects
4.	Describe the operator overloading, type conversion and inheritance concepts to develop reliable programs.
5.	Apply the concept of pointers, polymorphism and C++ stream classes to use with objects.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2262-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2262-1.2	2	3	-	-	3	-	-	-	-	-	-	1	-	1
EE2262-1.3	2	3	-	-	3	-	-	-	-	-	-	1	-	1
EE2262-1.4	2	3	-	-	3	-	-	-	-	-	-	1	-	1
EE2262-1.5	2	3	-	-	3	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Balagurusamy, E, "Object-Oriented Programming with C++", TMH,6th edition, 2013.
2. Herbert Schildt, "C++, The Complete Reference", TMH, 4th edition,2002
3. Farrell, "Object-Oriented Programming with C++", Cengage Learning, Fourth Edition, 2009.

REFERENCE BOOKS:

1. Bjarne Stroustrup, "The C++ programming language", Pearson Education, 4th edition, 2013.
2. Bhave, "Objected oriented programming with C++", Pearson Education, First Edition, 2012.

E Books / MOOCs/ NPTEL

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-088-introduction-to-c-memory-management-and-c-object-oriented-programming-january-iap-2010/lecture-notes/
2. http://nptel.ac.in/courses/106105151/

MATLAB PROGRAMMING FOR ENGINEERS

Course Code:	**EE2263-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P)	**3:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electrical and Electronics Engineering

Course Objective:

1. To get familiarized with concept of MATLAB programming for array, matrices, logical operations and conditional statements
2. To acquainted with MATLAB programming for numerical methods to solve differential equations.
3. To analyse the electrical circuits using MATLAB Simulink .

UNIT-I

15 Hours

An Overview of MATLAB®: MATLAB Interactive Sessions, Menus and the Toolbar, Script Files and the Editor/Debugger, The MATLAB Help System
Getting started: Creating MATLAB variables, Overwriting variable, Error messages, Managing the workspace, Miscellaneous commands
Arrays and Matrices: Creating vector, creating matrix, Matrix indexing, Colon operator, creating a sub-matrix, deleting row or column, Transposing a matrix, Concatenating matrices, Matrix generators, Special matrices, Matrix arithmetic operations, Array arithmetic operations, Matrix inverse
Control flow and operators: Relational Operators and Logical Variables, Logical Operators and Functions, Conditional Statements, for Loops, while Loops, The switch Structure, Operator precedence
Plots: Introduction to plots, x-y Plotting Functions, Additional Commands and Plot Types, Interactive Plotting, subplots, Three-Dimensional Plots.
Functions and Files: Elementary Mathematical Functions, User Defined Functions

UNIT-II

15 Hours

Linear Algebraic Equations: Matrix Methods for Linear Equations, The Left Division Method, Underdetermined Systems, Overdetermined Systems, A General Solution Program
Numerical Methods for Calculus and Differential Equations: Numerical Integration, Numerical Differentiation, First-Order Differential Equations, Higher-Order Differential Equations, Special Methods for Linear Equation
Statistics, Probability, and Interpolation: Statistics and Histograms, Normal Distribution. Random Number Generation, Interpolation

UNIT-III

10 Hours

Introduction to Simulink, Simulink model of a first order and second order systems, simulation of RLC series circuit using Simulink blocks (mathematical modelling).
Simscape Electrical: Introduction Simscape Electrical Blocks, overview of Specialized power system blocks, simulation of simple electrical circuits, RLC series circuit

Course Outcomes: At the end of the course student will be able to

1.	Use matrices and operators in MATLAB programming
2.	Use and write functions; use MATLAB toolbox
3.	Apply linear algebra and numerical methods using MATLAB programming
4.	Write MATLAB programs for statistics and probability
5.	Use Simulink and Simscape tools for modelling electrical systems.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
EE2263-1.1	1	-	-	-	3	-	-	-	-	-	-	-
EE2263-1.2	1	-	-	-	3	-	-	-	-	-	-	-
EE2263-1.3	1	-	-	-	3	-	-	-	-	-	-	-
EE2263-1.4	1	-	-	-	3	-	-	-	-	-	-	-
EE2263-1.5	1	-	-	-	3	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS

1. William J. Palm III, “Introduction to MATLAB® for Engineers”, Third Edition, 2011, McGraw-Hill.
2. Timmy Siauw, Alexandre Bayen, “An Introduction to MATLAB® Programming and Numerical Methods for Engineers”, 2014, Elsevier Science
3. O. Beucher, M. Weeks, “Introduction to MATLAB & SIMULINK (A Project Approach)”, Third Edition, 2008, Laxmi Publications Pvt Limited
4. Eugeniy E. Mikhailov, “Programming with MATLAB for Scientists: A Beginner’s Introduction”, 2018, CRC Press

REFERENCE BOOKS

1. Dorothy C. Attaway, Stormy Attaway, “MATLAB: A Practical Introduction to Programming and Problem Solving”, 3rd illustrated edition, 2013, Elsevier Science
2. Patrick Marchand, O. Thomas Holland, “Graphics and GUIs with MATLAB”, Third Edition, 2003, CRC Press
3. “Select a web site,” Create and Run a Simple App Using App Designer - MATLAB & Simulink. [Online]. Available: https://www.mathworks.com/help/matlab/creating_guis/create-a-simple-app-or-gui-using-app-designer.html. [Accessed: 31-Dec-2022].

COMPUTATIONAL LINEAR ALGEBRA

Course Code:	**EE3261-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA1001-2, MA2008-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the Vectors and Matrices
2.	To aquatinted with linear mapping, measurements
3.	To understand fundamental theorem of linear algebra
4.	To know the Least squares algorithm for data science

UNIT-I

Vectors and Matrices	**08 Hours**
Quantities, Vectors, Matrices, Linear combinations, Vectors and Matrices in data science, Linear mapping: Functions, Measurements, Compositions.	
Vector Spaces: Formal rules, Algebraic structures, Data redundancy: Linear dependence, basis and dimensions	**07 Hours**

UNIT-II

Fundamental theorem of linear algebra	**10 Hours**
Data Information , Data Information , Mappings: Vector spaces of mappings and matrix representations, measurement of mappings. The Singular Value Decomposition (SVD) : Orthogonal matrices, Intrinsic basis of a linear mapping and SVD solution of linear algebra problems.	
Least Square: Data Compression, projection, Gram-Schmidt, QR solution of linear algebra problems, Model Reduction.	**05 Hours**

UNIT-III

Data Transformation: Gaussian elimination and row echelon reduction, LU-factorization, Inverse matrix, **Eigen Problems:** Data Stability: The eigenvalue problem, Computation of the SVD, Data resonance	**10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Describe the vectors and matrices in data science perspective
2.	Apply vector space in the data science
3.	Explain the significance of fundamental theorems of linear algebra in data science
4.	Apply least squares as tool for data compression, projections.
5.	Analyse the importance of change of basis as data transformation

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3261-1.1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3261-1.2	3	3	-	-	2	-	-	-	-	-	-	-	-	-
EE3261-1.3	3	3	-	-	2	-	-	-	-	-	-	-	-	-
EE3261-1.4	3	3	-	-	3	-	-	-	-	-	-	-	-	-
EE3261-1.5	3	3	-	-	3	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Lloyd N. Trefethen and D. Bau, "Numerical Linear Algebra", SIAM (1997), ISBN 0-89871-361-7.
2.	Linear algebra for data science by SORIN MITRAN, Department of Mathematics University of North Carolina at Chapel Hill.
3.	Introduction to Linear Algebra by Gilbert Strang, Sixth Edition (2023), ISBN : 978-17331466-7-8

REFERENCE BOOKS:

1.	D. Kincaid and W. Cheney, "Numerical Analysis: Mathematics of Scientific Computing", 3rd Ed, Brooks/Cole (2002), ISBN 0-534-38905-8

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/111107106

OPERATING SYSTEMS FUNDAMENTALS

Course Code:	**EE2361-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concepts of the operating system.
2.	To explain the concepts of structure in operating systems
3.	To discuss on the process management and treads in operating systems
4.	To understand the memory management and memory allocation in operating systems.
5.	To introduce the concept of virtual memory in operating systems with an example of UNIX.

UNIT-I

Introduction and Overview Of Operating Systems	**08 Hours**

Operating system, Goals of an O.S, Operation of an O.S, Resource allocation and related functions, User interface related functions, Classes of operating systems, O.S, and the computer system, Batch processing system, Multiprogramming systems, Time-sharing systems, Real-time operating systems, distributed operating systems.

Structure of the Operating Systems	**08 Hours**

Operation of an O.S, Structure of the supervisor, Configuring and installation of the supervisor, Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel-based operating systems, and Microkernel based operating systems.

UNIT-II

Process Management	**07 Hours**

Process concept, Programmer view of processes, OS view of processes, Interacting processes, Threads, Processes in UNIX, Threads in Solaris

Memory Management	**07 Hours**

Memory allocation to programs, Memory allocation preliminaries, Contiguous and non-contiguous allocation to programs, Memory allocation for program-controlled data, kernel memory allocation

UNIT-III

Virtual Memory	**10 Hours**

Virtual memory basics, Virtual memory using paging, Demand paging, Page replacement, Page replacement policies, Memory allocation to programs, Page sharing, UNIX virtual memory. Scheduling: Fundamentals of scheduling, Long-term scheduling, Medium and short-term scheduling, Real-time scheduling, Process scheduling in UNIX.

Course Outcomes: At the end of the course student will be able to

1.	Summarize the overview of operating systems.
2.	Describe the structure of operating systems.
3.	Analyze the concept of process management, processes, and threads.
4.	Illustrate memory allocation and management in operating systems.
5.	Analyze the concept of virtual memory and scheduling algorithms as implemented in UNIX.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2361-1.1	1	2	-	-	-	-	-	-	-	-	-	1	-	-
EE2361-1.2	1	2	-	-	-	-	-	-	-	-	-	1	-	-
EE2361-1.3	2	3	-	-	2	-	-	-	-	-	-	2	-	1
EE2361-1.4	2	2	1	3	2	-	-	-	-	-	-	2	-	2
EE2361-1.5	2	2	1	3	2	-	-	-	-	-	-	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. D.M. Dhamdhare, “Operating Systems A Concept-Based Approach” Mcgraw Hill Higher Education, 2nd Ed, 2007.
2. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, “Operating System Principles”, Wiley, 8th Edition, 2009.

REFERENCE BOOKS:

1. Silberschatz and Galvin, “Operating Systems Concepts”, John Wiley, 5th Edition, 2001.
2. P.C.P. Bhatt, “Operating Systems”, PHI, 2nd Edition, 2008.
3. Harvey M Deital, “Operating Systems”, Pearson Education, 3rd Edition.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/106105214
2. https://www.coursera.org/specializations/codio-introduction-operating-systems

INTRODUCTION TO MACHINE LEARNING WITH PYTHON

Course Code:	**EE3361-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA1001-2, MA1003-1, MA2004-1, MA2008-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To analyse the given data set.
2.	To perform Linear and non-linear regression techniques using scikit learn package.
3.	To perform kNN and DT techniques using scikit learn package.
4.	To perform Logistic regression and SVM techniques using scikit learn package.
5.	To perform clustering and Design a recommender system

UNIT-I

Introduction	**03 Hours**
Introduction to Machine Learning, Python for Machine Learning, Supervised vs Unsupervised.	
Regression	**12 Hours**
Introduction to Regression, Simple Linear Regression, Model Evaluation in Regression Models, Evaluation Metrics in Regression Models, Multiple Linear Regression, Gradient Descent Method, Non-Linear Regression.	

UNIT-II

Classification	**15 Hours**
Introduction, K-Nearest Neighbours, Evaluation Metrics in classification, Introduction to Decision Trees, Building Decision Trees(DT), Introduction to Logistic Regression, Logistic regression vs Linear regression, Logistic Regression Training, Support Vector Machine(SVM).	

UNIT-III

Clustering:	**05 Hours**
Introduction, Introduction to k-Means, Introduction to Hierarchical Clustering, DBSCAN	
Recommender Systems	**05 Hours**
Introduction, Content-based Recommender Systems, Collaborative Filtering.	

Course Outcomes: At the end of the course student will be able to

1.	Identify the characteristics of datasets and compare the trivial data for various applications
2.	solve regression problems using linear/non-linear regression analysis techniques for various applications.
3.	Perform classification using kNN, DT for various applications
4.	solve classification problem using Logistic regression and SVM for various applications
5.	Perform clustering analysis and design recommender system for various applications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3361-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE3361-1.2	2	3	-	-	3	-	-	-	-	-	-	1	-	1
EE3361-1.3	2	3	-	-	3	-	-	-	-	-	-	1	-	1
EE3361-1.4	2	3	-	-	3	-	-	-	-	-	-	1	-	1
EE3361-1.5	2	3	-	-	3	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Rebala, A. Ravi, and S. Churiwala, "An Introduction to Machine Learning", 1st ed. Springer International Publishing, 2019.
2. Miroslav Kubat, "An Introduction to Machine Learning ", 1st ed. Springer International Publishing, 2015.

REFERENCE BOOKS:

1. A. C. Müller and S. Guido, "Introduction to Machine Learning with Python A Guide for Data Scientists", 1st ed. O'Reilly Media, Inc., 2016
2. Aurélien Géron, "Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems", 2nd ed. O'Reilly Media, Inc., 2019

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/106105152
2. https://www.coursera.org/learn/machine-learning-with-python

PROBABILITY AND INFORMATION THEORY

Course Code:	**EE3362-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA2008-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To Understand different methods of information and probabilistic modelling
2.	To understand the importance of statistical interference in data processing
3.	To understand the inequality measure of information

UNIT-I

Information and probabilistic modelling:	**15 Hours**

information, uncertainty, basic concepts of probability, Markov inequality, limit theorems, Uncertainty, compression, and entropy: source model, motivating examples, a compression problem, Shannon entropy, random hash. Randomness and entropy: uncertainty and randomness, Total variation distance, generating uniform bits, generating from uniform bits, typical sets and entropy.

UNIT-II

Information and statistical inference:	**15 Hours**

Hypothesis testing and estimation, examples, the log-likelihood ratio test, Kullback-Leibler divergence and Stein's lemma, properties of KL divergence,

Information per coin toss, multiple hypothesis testing, mutual information, Fano's inequality, Properties of measures of information-1: Definitions, chain rule, shape of information functions (boundedness, concavity/convexity, non-negativity), data processing inequality.

UNIT-III

Properties of measures of information-	**10 Hours**

Proof of Fano's inequality, variational formulae, capacity as information radius, proof of Pinsker's inequality, continuity of entropy; Information theoretic lower bounds: Lower bound for source coding, lower bound for Stein's lemma.
lower bound for randomness generation, strong converse, lower bound for minmax estimation; Compression Variable length source codes

Course Outcomes: At the end of the course student will be able to

1.	Explain the concept of uncertainty, probability and entropy
2.	Describe the randomness and total variation distance
3.	Analyse the statistical interferences using hypothesis testing and estimation methods
4.	Explain the Properties of measures of information
5.	Analyse the Information theoretic lower bounds

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE3362-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE3362-1.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
EE3362-1.3	2	2	-	-	-	-	-	-	-	-	-	1	2	-
EE3362-1.4	2	3	-	-	-	-	-	-	-	-	-	1	2	-
EE3362-1.5	3	2	-	-	-	-	-	-	-	-	-	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. T. Cover and J. Thomas, Elements of Information Theory, Second edition, Wiley, 2006
2. I. Csiszar and J. Korner, Information Theory: Coding Theorems for Discrete Memoryless Systems, Second edition, Cambridge, 2011.
3. T. S. Han, Information spectrum methods in Information Theory, Stochastic Modelling and Applied Probability series, Springer, 2003.

Professional Elective Courses (AIDS Stream)

Data Science Engineering

Course Code:	**EE2271-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the Python functions and types
2.	To know the python objects and expressions
3.	To understand simple statistical models and the basics of machine learning techniques of regression.
4.	Skills in the use of tools such as python, IDE

UNIT-I

Introduction — **15 Hours**

Introduction to Data Science using the Python programming language: Python functions, types and sequences, reading writing CSV files, python dates and times, advanced python objects, Advanced python Lambda and List Comprehensions. Manipulating text with regular expression, Expression operations documentations.
Introduction to Pandas, The series data structure, querying a series, data frame and data structure, data frame indexing and loading, Querying a data frame, indexing a data frame, missing values.

UNIT-II

Data Analysis — **15 Hours**

Descriptive statistics, data preparation. Exploratory Data Analysis data summarization, data distribution, measuring asymmetry. Sample and estimated mean, variance and standard score. Statistical Inference frequency approach, variability of estimates, hypothesis testing using confidence intervals, using p-values

Supervised Learning: First step, learning curves, training-validation and test. Learning models generalities, support vector machines, random forest. Examples

UNIT-III

Regressions Analysis — **10 Hours**

Regression analysis, Regression: linear regression simple linear regression, multiple & Polynomial regression, Sparse model. Unsupervised learning, clustering, similarity and distances, quality measures of clustering, case study.

Course Outcomes: At the end of the course student will be able to

1.	Describe what Data Science is and the skill sets needed to be a data scientist
2.	Comprehend the data structure and querying data frame
3.	Explain the significance of exploratory data analysis (EDA) in data science
4.	Learn the supervised learning, SVM in data science
5.	Apply basic machine learning algorithms (Linear Regression)

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2271-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2271-1.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
EE2271-1.3	2	2	-	-	-	-	-	-	-	-	-	1	2	-
EE2271-1.4	2	3	-	-	-	-	-	-	-	-	-	1	2	-
EE2271-1.5	3	-	-	-	-	-	-	-	-	-	-	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

2.	Introduction to Data Science a Python approach to concepts, Techniques and Applications, Igual, L;Seghi', S. Springer, ISBN:978-3-319-50016-4
3.	Data Analysis with Python A Modern Approach, David Taieb, Packt Publishing, ISBN-9781789950069
4.	Python Data Analysis, Second Ed., Armando Fandango, Packt Publishing, ISBN: 9781787127487
4.	https://www.coursera.org/learn/python-data-analysis/home

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Course Code:	**EE2272-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To Understand concepts of Artificial Intelligence and different types of intelligent agents and their architecture
2.	To Formulate problems as state space search problem & efficiently solve them.
3.	To Understand the working of various informed and uninformed searching algorithms and different heuristics
4.	To Reasoning with uncertainty and Machine learning algorithms
5.	To Understand how learning happens in neural networks

UNIT-I

Introduction to AI, Intelligent Agents and Searching — **15 Hours**

Definition of AI, birth of AI, brief history, Turing test, Types of environment, Types of agents, PEAS(Performance measure , Environment, Actuators, Sensors), Introduction to searching, State Space, SAGP (State, Action, Goal test, Path cost), DFS, BFS (Completeness, Time complexity, Space complexity, Optimality), Heuristics, Local Search Algorithm, Hill Climbing. Applications of Artificial Intelligence in real word.

UNIT-II

CSP, Game Playing and Logics — **15 Hours**

Constrain Satisfaction Problems examples, Approaches to solve CSPs, Test and generate method, back tracking. Game Playing, Optimal decision in games, Min Max algorithm, Evaluation functions, Introduction to Propositional Logic and First Order Logic, Syntax, Substitution, Unification, Deduction, Soundness, Completeness, Consistency, Satisfiability, Expert Systems.

UNIT-III

Uncertain Knowledge, Reasoning and Machine Learning — **10 Hours**

Probabilistic Reasoning, Review of Probability Theory, Probabilistic Inference Rules, Bayes Theorem, examples of Bayes theorem, Introduction to Learning, Taxonomy of Learning Systems, Concept Learning, Find-S algorithm, Candidate Elimination Algorithm. Introduction to Neural Networks, Biological Neural Networks, Artificial Neural Networks, Perceptron, Perceptron Learning Rule, Delta Rule, Applications of Neural Networks.

Course Outcomes: At the end of the course student will be able to

1.	Describe the concepts of Artificial Intelligence and different types of intelligent agents and their architecture
2.	Explain the methods of heuristic , local and hill climbing searching algorithm
3.	Describe the solutions for Constrain satisfaction problems
4.	Explain the propositional logic and first order logic, syntax
5.	Describe the Uncertain Knowledge, Reasoning and Machine Learning

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2272-1.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2272-1.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
EE2272-1.3	2	2	-	-	-	-	-	-	-	-	-	1	2	-
EE2272-1.4	2	3	-	-	-	-	-	-	-	-	-	1	2	-
EE2272-1.5	2	2	-	-	-	-	-	-	-	-	-	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Stuart Russell and Peter Norvig – Artificial Intelligence A Modern Approach, PEARSON Education
2. Simon Haykin -Neural Networks PHI.

REFERENCE BOOKS:

1. N. P. Padhy – Artificial Intelligence and Intelligence Systems, OXFORD publication
2. B. YagnaNarayana - Artificial Neural Networks, PHI

INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS

Course Code:	**EE2273-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA2008-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To introduce the concept and use of ANN
2.	To explain the concept of supervised learning and various leaning algorithms
3.	To illustrate the use of Accelerating learning process and need of prediction network
4.	To familiarize with the concept of Learning vector quantizing and associative modeling
5.	To understand the need of optimization and different optimization algorithms

UNIT-I

Introduction	**06 Hours**
Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks.	
Supervised learning	**04 Hours**
Supervised learning, single layer networks, perceptron's, linear separability, perceptron training algorithm, guarantees of success, modifications	
Multiclass networks-I	**05 Hours**
Multiclass networks-I, multilevel discrimination, preliminaries, back propagation, setting parameter values, theoretical results	

UNIT-II

Accelerated learning process	**04 Hours**
Accelerated learning process in layered neural network, application, mandaline, adaptive multilayer networks	
Prediction networks	**04 Hours**
Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner take all networks	
Learning vector quantizing	**04 Hours**
Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, recognition	
Associative models	**04 Hours**
Associative models, hop field networks, brain state networks, Boltzmann machines, hetero associations.	

UNIT-III

Optimization using hop filed networks	**09 Hours**
Optimization using hop filed networks, simulated annealing, random search, evolutionary computation	

Course Outcomes: At the end of the course student will be able to

1.	Describe the architecture of neural network to identify the functionalities of different layers
2.	Apply the single layer and multilayer learning algorithms to solve nonlinear system
3.	Describe the accelerated learning process and unsupervised learning algorithm

4.	Analyse the learning vector quantizing and associative modelling techniques to solve uncertainty in the system
5.	Describe the various neural network optimization algorithms

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE2273-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2273-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2273-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2273-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2273-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Kishan Mehrotra, C. K. Mohan, Sanjay Ranka, Elements of artificial neural networks, 2nd Edition, Penram International Publishing India Pvt. Ltd, 2009
2. Martin T. Hagan, Demuth and Beale, "Neural network design", 2nd Edition, Cengage Learning, 2008.

REFERENCE BOOKS:

1. R, Schalkoff, Artificial neural networks, 2nd Edition, Tata McGraw - Hill Education, 1998.
2. J. Zurada, "Introduction to artificial neural systems", Jaico, 2003
3. Simon Haykin, Neural networks, 3rd Edition, Phi Learning Pvt. Ltd-New Delhi, 2010
4. Hertz, Krogh, Palmer, Introduction to theory of neural computation, Addison Wesley, 1991.

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/117105084/

AI APPLICATIONS TO POWER SYSTEMS

Course Code:	**EE4271-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To study the Difference between Algorithmic based methods and knowledge based methods
2.	To understand the use of the soft computing techniques for voltage control problems
3.	To know the appropriate AI framework for solving power system protection problems
4.	To study the different AI techniques for demand forecasting
5.	To know the Adaptive AI techniques in the power system protection and control

UNIT-I

Introduction	**07 Hours**
Definition of AI difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA Fuzzy logic and Hybrid systems: Concept of Fuzzy in Power system, Fuzzy Techniques and Applications in power system	
Comparison among Various Artificial Intelligence Techniques	**08 Hours**
ANN, Fuzzy, Evolutionary algorithms, Expert systems, Hybrid systems: Fuzzy expert system Hybrid, Neural Network system Hybrid, Application in Power system Artificial Intelligence techniques for voltage control: Introduction, Algorithm methods, Voltage collapse monitoring, Reactive power management, Combined active and reactive dispatch, AI techniques for Voltage control	

UNIT-II

AI Techniques for protection systems	**05 Hours**
Introduction: An expert system for Protective relaying settings, Fuzzy logic for power system protection, Artificial neural network in phase selection Artificial Neural network for static security assessment: Introduction to power system security assessment, AI techniques to power system security assessment- Fuzzy techniques, ANN	
A supervised ANN for power system security prediction	**03 Hours**
ANN Architecture, Training set selection, A new prediction performance measure, ANN performance evaluation	
Intelligence systems for demand forecasting	**08 Hours**
Introduction, stages in building a forecast model, Identifying the model, survey of intelligence system for demand forecasting	

UNIT-III

A practical application and implementation of adaptive techniques using neural networks into auto-reclose protection and system control	**09 Hours**
Introduction, Auto recloser description: Conventional scheme, Adaptive reclose description, neural network description, system simulation, fault records, feature extraction, Neural Network training, Neural Network testing	

Course Outcomes: At the end of the course student will be able to

1.	List the various soft computing and hard computing techniques to apply in power system
2.	Compare different AI techniques to choose an appropriate method for voltage control in power system
3.	Select appropriate AI framework for solving power system protection problems
4.	Describe various AI techniques for demand forecasting
5.	Describe the Adaptive AI techniques to apply in power system protection and control

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE4271-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
EE4271-1.2	2	2	3	-	-	-	-	-	-	-	-	1	-	1
EE4271-1.3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
EE4271-1.4	2	3	-	-	-	-	-	-	-	-	-	1	-	-
EE4271-1.5	2	3	-	-	-	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	K. Warwick, Arthur Ekwue, Raj Aggarwal, “Artificial Intelligence Techniques in Power Systems”, Institution of Electrical Engineers
2.	Loi Lei Lai John “Intelligent system applications in power engineering: evolutionary programming and neural network”, Wiley, 1998

REFERENCE BOOKS:

1.	Dan W Patterson, “Introduction to Artificial Intelligence and Expert System”, PHI
2.	Elaine Rich, Kevin Knight, “Artificial intelligence”, McGraw-Hill, 1991

FUZZY LOGIC CONTROL

Course Code:	**EE2371-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA1001-1, EE3002-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To differentiate conventional Set theory and Fuzzy logic
2.	To study the concept of linguistic variables and inference rules
3.	To analyse the application of fuzzy logic controller systems
4.	To understand the fuzzy knowledge-based controllers (FKBC)
5.	To understand the process of performance monitoring and adaption mechanism using FKBC

UNIT-I

Introduction	**07 Hours**
Fuzzy sets, Properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, cardinality operations on fuzzy relations, Fuzzy Cartesian product and composition, fuzzy Tolerance and equivalence relations	
Theory of approximate reasoning	**08 Hours**
Linguistic variables, linguistic hedges, Fuzzy if then statements, inference rules, compositional rule of inference, graphical technique of inference, Fuzzification and defuzzification procedures	

UNIT-II

Development of membership functions	**08 Hours**
Intuition, inference, rank ordering, neural networks, genetic algorithm, inductive reasoning Assumptions in a Fuzzy control system design, Simple fuzzy logic controllers, Examples of fuzzy logic controllers	
	08 Hours
Relations, Introduction to fuzzy relations Projections, Equivalence relation, transitive closure, compatibility relation	

UNIT-III

Fuzzy knowledge-based controllers (FKBC)	**09 Hours**
Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, FKBC as a Non-linear transient element, Design of P, PI, PD, PID controllers, sliding mode FKBC, Sugeno FKBC	

Course Outcomes: At the end of the course student will be able to

1.	Describe the fundamentals of Fuzzy logic to apply in systems with uncertainty
2.	Classify the linguistic variables & inference rules to formulate knowledge based system
3.	Design sample fuzzy control systems to study the system behavior
4.	Analyze fuzzy knowledge-based controllers (FKBC) to compare its performance with conventional controllers
5.	Describe the adaptive fuzzy control system to enhance the performance of FKBC systems

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE2371-1.1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2371-1.2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2371-1.3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2371-1.4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
EE2371-1.5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

If any task is given using simulation software PO5, PO9, PO10 and PSO2

TEXTBOOKS:

1. Timothy J Ross, "Fuzzy Logic with engineering applications", 3rd Edition, John Wiley And Sons , 2010.
2. Dimiter Driankov, Hans Hellendoorn, Michael Reinfrank- "An introduction to Fuzzy control", Narosa Publishers India, 1996
3. G. J. Klir and T. A. Folger, "Fuzzy sets uncertainty and information" [Paris] :Didero publishers , 1996

REFERENCE BOOKS:

1. R. R. Yaser and D. P. Filer "Essentials of Fuzzy modelling and control" John Wiley, 1994
2. Yen, "Fuzzy Logic Intelligence control and Information" Pearson education. 1st edition,2002
3. M Amirthavalli "Fuzzy logic and Neural networks", SciTech Publications (India) Pvt Limited, 2004

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/108104049
2. http://videolectures.net/acai05_berthold_fl/

INTRODUCTION TO BIG DATA ANALYTICS

Course Code:	**EE2372-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Understand fundamentals of Big Data analytics
2.	Explore the Hadoop framework and Hadoop Distributed File system
3.	Illustrate the concepts of NoSQL using MongoDB and Cassandra for Big Data
4.	Employ MapReduce programming model to process the big data

UNIT-I

Introduction to Big Data Analytics:	**08 Hours**
Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data Storage and Analysis, Big Data Analytics Applications and Case Studies.	
Introduction to Hadoop	07 Hours
Introduction, Hadoop and its Ecosystem, Hadoop Distributed File System, MapReduce Framework and Programming Model, Hadoop Yarn, Hadoop Ecosystem Tools. Hadoop Distributed File System Basics (T2): HDFS Design Features, Components, HDFS User Commands.	

UNIT-II

Big Data Management	**08 Hours**
NoSQL Big Data Management, MongoDB and Cassandra: Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks, MongoDB, Databases, Cassandra Databases.	
MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.	**07 Hours**

UNIT-III

Regressions Analysis	**10 Hours**
Machine Learning Algorithms for Big Data Analytics: Introduction, Estimating the relationships, Outliers, Variances, Probability Distributions, and Correlations, Regression analysis, Finding Similar Items, Similarity of Sets and Collaborative Filtering, Frequent Itemsets and Association Rule Mining.	

Course Outcomes: At the end of the course student will be able to

1.	Understand fundamentals of Big Data analytics.
2.	Investigate Hadoop framework and Hadoop Distributed File system.
3.	Illustrate the concepts of NoSQL using MongoDB and Cassandra for Big Data.
4.	Demonstrate the MapReduce programming model to process the big data along with Hadoop tools.
5.	Use Machine Learning algorithms for real world big data.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
EE2372-1.1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
EE2372-1.2	2	2	-	-	-	-	-	-	-	-	-	-	1	-
EE2372-1.3	2	2	-	-	-	-	-	-	-	-	-	1	1	-
EE2372-1.4	2	3	-	-	-	-	-	-	-	-	-	1	1	-
EE2372-1.5	3	-	-	-	-	-	-	-	-	-	-	1	1	-

1: Low 2: Medium 3: High

TEXTBOOKS:

5. Raj Kamal and Preeti Saxena, “Big Data Analytics Introduction to Hadoop, Spark, and Machine-Learning”, McGraw Hill Education, 2018 ISBN: 9789353164966.
6. Douglas Eadline, "Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1stEdition, Pearson Education, 2016. ISBN-13: 978-9332570351

REFERENCE BOOK:

1. Tom White, “Hadoop: The Definitive Guide”, 4th Edition, O‟Reilly Media, 2015.ISBN-13: 978-9352130672
2. Boris Lubinsky, Kevin T Smith, Alexey Yakubovich, "Professional Hadoop Solutions", 1stEdition, Wrox Press, 2014ISBN-13: 978-8126551071
3. Eric Sammer, "Hadoop Operations: A Guide for Developers and Administrators",1stEdition,

IMAGE PROCESSING

Course Code:	**EE3371-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE3003-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives: This course will enable students to

1.	Recall the mathematical & signal principles, forming the basis for methods for image processing.
2.	Understand image representation, enhancement, filtering, restoration, analysis &reconstruction
3.	Know the processing techniques including various image transformations, image reconstruction, segmentation & recognition
4.	Design & conduct imaging experiments using MATLAB
5.	Convert image from RGB to gray, black & white, remove blurring effects, noise reduction, edge detection, compression and segmentation

UNIT-I

Definition of Digital Image Processing	**07 Hours**
Origins and examples of DIP, Fundamental steps in DIP, Elements of visual perception, A simple image formation model, Concepts of sampling & quantization, Representation of digital images, Spatial and Gray level resolution, Zooming& Shrinking of digital images, Basic relationships between pixels. Understanding of Satellite image & Concept of False Color Composite	
Image Enhancement in Spatial domain	**04 Hours**
Concept & Importance of Histogram Some basic gray level transformations, Histogram processing, Basics of spatial filtering, smoothing spatial filters, sharpening filters.	
Image Enhancement in Frequency domain	**04 Hours**
Introduction to Fourier Transform & Frequency Domain Basics of filtering in frequency domain, Designing the filter in for smoothening and sharpening the images	

UNIT-II

Image Restoration	**06 Hours**
A model of image degradation & Restoration process, Noise models, Restoration in the presence of Noise only-spatial filtering, Periodic noise reduction by frequency domain filtering, Inverse filtering, Minimum Mean Square (Wiener) filtering	
Color Fundamentals	**05 Hours**
Color models, Pseudocolor Image processing, Basics of Full color image processing, Color transformations, Smoothing & Sharpening, Noise in color images, Color image compression	
Image Compression	**04 Hours**
Fundamentals, Image compression models, Some basic compression methods: Huffman coding, Arithmetic coding, Run length coding, JPEG, MPEG.	

UNIT-III

Morphological Image Processing	**10 Hours**
Introduction, Dilation & Erosion, Opening & Closing operations, Some basic morphological algorithms. Image Segmentation: Fundamentals, Point, Line & edge detection, Thresholding, Region-based segmentation.	

Course Outcomes: At the end of the course student will be able to

1.	Apply the image fundamentals and mathematical transforms for improving resolution of image.
2.	Apply spatial & frequency domain techniques to enhance the image .
3.	Explain the image restoration technique in presence & absence of noise and explain noise models: Gaussian, Raleigh, exponential, impulse, gamma and impulse
4.	Explain the image restoration technique in presence & absence of noise and explain noise models: Gaussian, Raleigh, exponential, impulse, gamma and impulse
5.	Apply morphological operations and segmentation techniques for detection region of interest.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3371-1.1	3	-	-	-	1	-	-	-	-	-	-	-	1	-
EE3371-1.2	3	-	-	-	1	-	-	-	-	-	-	-	1	-
EE3371-1.3	3	-	-	-	1	-	-	-	-	-	-	-	1	-
EE3371-1.4	3	-	-	-	1	-	-	-	-	-	-	-	1	-
EE3371-1.5	3	-	-	-	1	-	-	-	-	-	-	-	1	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R. C. Gonzalez and R. E Woods, “Digital Image Processing”, Pearson education (Asia)/Prentice Hall of India, 2nd Edition, 2004

REFERENCE BOOKS:

1. R. C. Gonzalez and R. E Woods, “Digital Image Processing”, Pearson education (Asia)/Prentice Hall of India, 2nd Edition, 2004

E-RESOURCES:

1. https://nptel.ac.in/courses/117105135
2. https://nptel.ac.in/courses/117105079/#

MATRIX METHODS IN MACHINE LEARNING

Course Code:	**EE3372-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA2004-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To Understand machine learning methods and algorithms through matrix-vector methods and optimization theory
2.	To Formulate a wide variety of machine learning problems as optimization models and solve them numerically. Understand practical implications of norm choice, regularization, and convexity.
3.	To Investigate an applied machine topic not explicitly covered in class and produce a research project that explains, analyzes, and discusses the topic.

UNIT-I

Introduction and Overview	**15 Hours**

Block matrices and norms, Linear dependence matrix and rank, Subspaces and linear equations, least squares, Vector derivatives and PSD matrices, orthogonality and Gram Schmidt, LS classification and cross validation.

UNIT-II

The singular value decomposition and iterative algorithms	**15 Hours**

Matrix norms and SVD, SVD geometry and PCA, low rank approximation and pseudoinverse, geometry and sensitivity, tradeoffs and regularizations, exaples, Iterative methods, proximal algorithm, gradient methods, stochaistic Gradient method

UNIT-III

More machine learning	**10 Hours**

Max-Margin SVM and Kernels, Dual formulation, neural network on perceptron, convolution neural networks, unsupervised learning and k-means, matrix problems and vectorization

Course Outcomes: At the end of the course student will be able to

1.	Describe the application of matrix methods for machine learning
2.	Apply of vector derivatives for machine learning
3.	Describe the application of SVD, PCA for machine learning
4.	Explain the geometry, sensitivity and regularizations to machine learning
5.	Analyse the SVM, kernels, CNN and unsupervised learning methods

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3372-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
EE3372-1.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-

EE3372-1.3	2	2	-	-	-	-	-	-	-	-	-	1	2	-
EE3372-1.4	2	3	-	-	-	-	-	-	-	-	-	1	2	-
EE3372-1.5	3	2	-	-	-	-	-	-	-	-	-	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Lars Eldén Matrix Methods in data minimin and pattern recognition,. SIAM, 2007.

Ability Enhancement Courses

RESEARCH METHODOLOGY

Course Code	**HU1010-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**2:0:0:0**	**Credits**	**02**
Total Teaching Hours	**25+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Any Dept.

Course Objectives:

1.	Explain the importance of research methodology, Explain the steps in defining the research problem.
2.	Explain methods of reviewing the literature and research design.
3.	Discuss the methods of designing sampling survey. Discuss methods of scaling and measuring of the data.
4.	Perform Hypothesis testing using the concept of mean and variance.
5.	Discuss interpretation and report writing techniques.

Unit-1

10 hours

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research and Scientific Method, Research Process

Defining the Research Problem: Research Problem, Selecting the Problem

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design

Unit-2

10 hours

Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors,

Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary, Data, Selection of Appropriate Method for Data Collection, Case Study Method.

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses,

Unit-3

5 hours

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Course Outcomes: At the end of the course student will be able to

1.	Explain the importance of research methodology, Explain the steps in defining the research problem.
2.	Explain methods of reviewing the literature and research design.
3.	Discuss the methods of designing sampling survey.
4.	Perform Hypothesis testing using the concept of mean and variance
5.	Discuss interpretation and report writing techniques.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
HU1010-1.1	3	2	-	-	-	-	-	-	-	3	-	-	-	-	1
HU1010-1.2	3	2	-	-	-	-	-	-	-	3	-	-	-	-	1
HU1010-1.3	3	2	-	-	-	-	-	-	-	3	-	-	-	-	1
HU1010-1.4	3	2	-	-	-	-	-	-	-	3	-	-	-	-	1
HU1010-1.5	3	2	-	-	-	-	-	-	-	3	-	-	-	-	1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. C.R. Kothari, Gaurav Garg, "Research Methodology: Methods and Techniques", New Age International 4th Edition, 2018
2. Ranjit Kumar, "Research Methodology a step-by step guide for beginners". (For the topic Reviewing the literature under Unit 2), SAGE Publications Ltd . 3rd Edition, 2011
3. Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005
4. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications, 2009

E Resources

1. NPTEL course material related to operations management, operations research and entrepreneurship

ECAD

Course Code	**EE3651-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**15+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-1, EE2001-1, EE2102-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To discuss AUTOCAD software package and single line diagram of substation & associated components
2.	To study wiring diagram of a room/ house
3.	To study the design of panel diagram
4.	To discuss design and sectional view of transformers, DC & AC machines
5.	To discuss design and procedure to draw winding diagrams for AC machines.

UNIT-I	
Introduction to CAD: Study of auto CAD graphics package.	**01 Hours**
Winding Diagrams:	
Single line diagram	**02 Hours**
Substation components and single line diagram of substation	
Wiring Diagram	**02 Hours**
Introduction to specifications of components for house wiring diagram, design house wiring diagram, cerate Bill of Materials	
Panel Diagram	**01 Hours**
Introduction to components of panel diagram and design of panel diagram	
UNIT-II	
Transformers	**03 Hours**
Introduction to design aspects of shell and core type transformers	
DC Machines	**03 Hours**
Introduction to design of Yoke, poles, armature and commutator of DC machine, Design of stator and rotor of AC machines	
UNIT-III	
AC machines	**02 Hours**
Sectional view of AC machine- stator and rotor	
Winding Diagram	**02 Hours**
Introduction to AC lap and wave winding diagram	

Suggested List of Experiments

1.	Study of AUTOCAD Packages
2.	Single line diagram of substation
3.	Design and draw house wiring diagram for a room/ house
4.	Design and draw panel diagram
5.	Sectional view of single and three phase core type transformers

6.	Sectional view of single and three phase shell type transformers
7.	Sectional Views of Yoke with Poles, Armature and Commutator dealt separately
8.	Alternator – Sectional Views of Stator and Rotor dealt separately.
9.	Developed winding diagram of AC machine- lap and wave winding

Course Outcomes: At the end of the course student will be able to

1.	Develop a Single Line Diagram of Generating Stations and substation using the standard symbols
2.	Design and draw wiring diagram and panel diagram using commands for a given specifications
3.	Construct sectional views of core and shell types transformers using the design data
4.	Construct sectional views of assembled DC and AC machine and their parts using the design data or the sketches
5.	Develop armature winding diagram for AC machines for the given specifications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE3651-1.1	2	3	-	-	3	-	-	-	-	-	-	2	-	-
EE3651-1.2	2	3	-	-	3	-	-	-	-	-	-	2	-	-
EE3651-1.3	2	3	-	-	3	-	-	-	-	-	-	2	-	-
EE3651-1.4	2	3	-	-	3	-	-	-	-	-	-	2	-	-
EE3651-1.5	2	3	-	-	3	-	-	-	-	-	-	2	-	-

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. A. K. Sawhney, "A course in Electrical Machine design", Dhanpat Rai, 6th Edition, 2013
2. K. L. Narang, "Electrical Engineering Drawing", Satya Prakashan, 2014

HARDWARE SYSTEM DESIGN

Course Code	**EE2651-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**15+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE2101-1, EE2601-1, EE2003-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To familiarize the student with the defining specifications for application
2.	To use open-source software tool for the creation of electronic schematic diagrams and PCB artwork
3.	To understand the various stages of design validation

UNIT-I

Introduction to Hardware design	**06 Hours**

Block diagram implementation, Understanding technical specifications and ordering information from datasheets. Library part creation using Software tool

UNIT-II

Layout	**06 Hours**

Schematic diagram, generating Bill of Materials, creation of Netlist
Pad Creation & footprint , Importing components to layout and setting constraints

UNIT-III

Routing and verification	**03 Hours**

Learning placement and Routing of components, Gerber creation & Verification of Gerber

Suggested List of Experiments

1.	Selection of right components for a defined specification
2.	Learning to read information from the datasheet
3.	Use open source tool for block diagram creation
4.	Draw electronic circuit using software tool
5.	Generate BoM and verify Netlist
6.	Footprint creation of each component
7.	Constraints setting and importing components to layout
8.	Placing of components in the board
9.	Drawing layout to interconnect components
10.	Generation of Gerber file
11.	Validation of Gerber in software tool

Course Outcomes: At the end of the course student will be able to

1.	Define specifications and select components for a given design
2.	Read datasheet for pin configuration and ordering information
3.	Use software tool for drawing a Schematic for electronic circuit
4.	Perform netlist verification of a given circuit
5.	Refer datasheet for layout considerations to generate PCB

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2651-1.1	2	3	2	-	3	-	-	-	-	-	-	2	-	-
EE2651-1.2	2	3	-	-	3	-	-	-	-	-	-	2	-	-
EE2651-1.3	2	3	-	-	3	-	-	-	-	-	-	2	-	1
EE2651-1.4	2	3	-	-	3	-	-	-	-	-	-	2	2	-
EE2651-1.5	2	3	-	-	3	-	-	-	-	-	-	2	-	-

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. KiCad EDA - Schematic Capture & PCB Design Software
2. Kraig Mitzner, "Complete PCB design using OrCAD capture and Layout", Elsevier, 2007.

INTERNET OF THINGS

Course Code	**EE2652-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**15+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Assess the genesis and impact of IoT applications, architectures in real world.
2.	Compare different Application protocols for IoT.
3.	Identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

UNIT-I

Introduction of IoT	**06 Hours**

Introduction of IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

UNIT-II

IoT protocols	**06 Hours**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security

UNIT-III

IoT physical servers and cloud offerings	**03 Hours**

Introduction to cloud storage models and communication APIs, WAMP – AutoBahn for IoT, Xively cloud for IoT

Suggested List of Experiments

1.	Design a Digital AC Voltmeter and Ammeter to measure the voltage and current in AC electrical circuits using microcontroller and display the values in LCD display.
2.	Measure the power and energy in electrical circuit using microcontroller and display the values in LCD display
3.	Interfacing temperature and humidity sensor with microcontroller and display the same in the lcd display
4.	Interfacing of microcontroller to Zigbee module
5.	Interfacing of microcontroller to Bluetooth module
6.	Interfacing of microcontroller to GSM module
7.	Interfacing of sensors to Raspberry Pi
8.	Setup a cloud platform to log the data
9.	Log Data using Raspberry Pi and upload to the cloud platform
10.	Design an IOT based system

Course Outcomes: At the end of the course student will be able to

1.	Describe the impact of IoT networks leading to new architectural models.
2.	Describe the challenges posed by IoT networks leading to new architectural models.
3.	Appraise the role of IoT protocols for efficient network communication.
4.	Identify the protocol to be used based on the application
5.	Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2652-1.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
-EE2652-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2652-1.3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2652-1.4	2	3	-	-	-	-	-	-	-	-	-	-	-	-
EE2652-1.5	2	3	-	-	-	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Srinivasa K G, "Internet of Things", CENGAGE Leaning India, 2017

REFERENCE BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN: 978-8173719547)
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

PYTHON PROGRAMMING ESSENTIALS

Course Code	**EE2653-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**15+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To write a simple python program with emphasis on syntax and semantics
2.	To write simple programs utilizing Lists, Tuples and Dictionaries.
3.	To write simple program by choosing appropriate conditional operator.
4.	To write simple program consisting of user defined functions.
5.	To study the concept of object oriented programming in python.

UNIT-I	
The Context of Software Development	**01 Hours**
Software, Development Tools, Learning Programming with Python, Writing a Python Program, The Python Interactive Shell	
Data, Expressions, Statements	**02 Hours**
Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments	
Control Flow, Functions	**02 Hours**
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional; Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion;	
UNIT-II	
Strings	**02 Hours**
Strings: string slices, immutability, string functions and methods, string module	
Lists	**02 Hours**
Lists as arrays, list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters	
Tuples	**01 Hours**
Tuple assignment, tuple as return value, Built-in functions.	
Dictionaries	**01 Hours**
Operations, built-in functions and methods; advanced list processing - list comprehension	
UNIT-III	
Python Object Oriented Programming	**04 Hours**
Concept of class, object and instances, Constructor, class attributes and destructors, Inheritance, overlapping and overloading operators, Adding and retrieving dynamic attributes of classes	

Suggested List of Experiments

1.	Study of datatypes, operations, functions and methods related to datatypes.
2.	write a program to find greatest common divisor or HCF of two numbers

3.	write a program to find a factorial of number **n** using recursive function
4.	Write a Python program to generate first ‘**n**’ Fibonacci numbers
5.	Build a program called “**GuessMyNumber**”. The computer will generate a random number between 1 and 10. The user types in a number and the computer replies “lower” if the random number is lower than the guess, “higher” if the random number is higher, and “correct!” if the guess is correct. The player can continue guessing until the guess is right.
6.	Write a binary search function which searches an item in a sorted list. The function should return the index of element to be searched in the list.
7.	Write a bubble sort function to sort a given list. Print the original and sorted lists.
8.	Write a program to remove all punctuations like “’!()-[]{};:’’’,\,<>,/,?,@,#,$,%^&*_~” from the string provided by the user.
9.	write a python program that accepts a sentence and calculate the number of words, digits, uppercase letters and lowercase letters

Course Outcomes: At the end of the course student will be able to

1.	Examine the Python syntax and semantics for writing effective Python program using operators, functions for a given problem statement.
2.	Use conditional and switch case statements to write programme in Python to tackle any decision-making scenario.
3.	Utilize the methods of Strings and Lists for write a programme for a given application.
4.	Utilize the methods of Tuples and Dictionaries for write a programme for a given application.
5.	Apply the knowledge OOPs to develop a Python programme using objects and classes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
EE2653-1.1	2	3												
EE2653-1.2	2	3			3							1		1
EE2653-1.3	2	3			3							1		1
EE2653-1.4	2	3			3							1		1
EE2653-1.5	2	3			3							1		1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	Gowrishankar S, Veena A, “Introduction to Python Programming”, 2019, CRC Press, Taylor & Francis Group.
2.	Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning
3.	Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014

INNOVATION AND DESIGN THINKING

Course Code	**ME1654-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**0:0:2:0**	**Credits**	**01**
Total Teaching Hours	**0+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To explain the concept of design thinking for product and service development
2.	To explain the fundamental concept of innovation and design thinking
3.	To discuss the methods of implementing design thinking in the real world.

Note: Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course
outcomes.

1. Lecturer method (L) does not mean only the traditional lecture method, but a ifferent type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain concepts
3. Encourage collaborative (Group Learning) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develops thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in multiple representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

List of Modules

UNIT-I

PROCESS OF DESIGN

Understanding Design thinking
Shared model in team-based design – Theory and practice in Design thinking – Explore the presentation
Tools for Design Thinking
Real-Time design interaction capture and analysis – Empathy for design
Teaching-Learning Process
Introduction about the design thinking: Chalk and Talk method
Theory and practice through presentation
Case studies on design thinking for real-time interaction and analysis

UNIT-II

Design Thinking in IT

Design Thinking to Business Process modeling – Scenario-based Prototyping

DT For strategic innovations
Growth – Storytelling representation – Strategic Foresight - Change – Sense Making – Maintenance - Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model design.
Teaching-Learning Process
Case studies on design thinking and business acceptance of the design
Business model examples of successful designs

UNIT-III

Design thinking workshop
Design Thinking Workshop Empathize, Design, Ideate, Prototype and Test
Teaching-Learning Process
Presentation by the students on the success of Live project on design thinking in a group of 4 students

Course Outcomes: At the end of the course student will be able to

1.	Appreciate various design process procedure
2.	Generate and develop design ideas through a different techniques
3.	Identify the significance of Design Thinking to Understand products

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
ME1651-1.1	2	-	2	-	-	-	-	-	-	-	-	-	-	-
ME1651-1.2	-	-	-	-	-	-	2	2	-	-	-	-	1	-
ME1651-1.3	-	-	-	-	-	-	-	-	-	3	3	-	-	1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage
2.	learning (International edition), Second Edition, 2013Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive
3.	Advantage", Harvard Business Press, 2009.Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand –
4.	Improve– Apply", Springer, 2011.Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at
5.	Business or Design School", John Wiley & Sons, 2013.Yousef Haik and Tamer M. Shahin, "Engineering Design Process", Cengage Learning,
6.	SecondEdition, 2011Jeanne Liedtka, Andrew King, Kevin Bennett, "Solving Problems with Design Thinking - Ten

E Resources

1	www.tutor2u.net/business/presentations/. /productlifecycle/default.html
2	https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf
3	www.bizfilings.com › Home › Marketing › Product Developmen
4	https://www.mindtools.com/brainstm.html

5	https://www.quicksprout.com/. /how-to-reverse-engineer-your-competit
6	www.vertabelo.com/blog/documentation/reverse-engineering https://support.microsoft.com/en-us/kb/273814
7	https://support.google.com/docs/answer/179740?hl=en
8	https://www.youtube.com/watch?v=2mjSDIBaUlM thevirtualinstructor.com/foreshortening.html https://dschool.stanford.edu/.../designresources/.../ModeGuideBOOTCAMP2010L.pdf https://dschool.stanford.edu/use-our-methods/ 6. https://www.interactiondesign. org/literature/article/5-stages-in-the-design-thinking-process 7. http://www.creativityatwork.com/design-thinking-strategy-for-innovation/ 49 8. https://www.nngroup.com/articles/design-thinking/ 9. https://designthinkingforeducators.com/design-thinking/ 10. www.designthinkingformobility.org/wp-content/.../10/NapkinPitch_Worksheet.pdf
9	Activity Based Learning (Suggested Activities in Class)/ Practical Based learning http://dschool.stanford.edu/dgift/

Vocational Education Courses

SOLDERING PRACTICE

Course Code:	**EE2551-1**	**Course Type**	**VEC**
Teaching Hours/Week (L:T: P: S)	**0:0:2:0**	**Credits**	**01**
Total Teaching Hours	**0+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand basics of manual soldering
2.	To identify various types of components and method of soldering
3.	To setup soldering workstation and understand temperature-controlled soldering
4.	To verify soldered PCB by visual inspection and standard test procedures
5.	To understand the necessity of workplace safety

UNIT-I

Introduction to Manual Soldering Technician: **06 Hours**

Identify the role of a manual soldering and visual inspection operator. Categorise the electronic components and understand their characteristics. Distinguish between different types of capacitors. Illustrate the construction and application of AC, DC, Motor-capacitors. Define the concepts of electrostatic discharge, capacitance, power factor, leakage, current/voltage specifications, temperature sensitivity, polarity, etc. List different types of soldering techniques and the raw material specific to the technique. Demonstrate how to do soldering without any damage as per standard operating procedure. Identify various stages of component preparation for through-hole assembly. Identify the parameters of line inspection and inspection of the assembled board. Comply with IPC 610 and 5S standards for soldering.

UNIT-II

Manually Solder Components: **06 Hours**

Inspect the wound capacitors / metal caps / assembled board received for soldering. Interpret the job sheet for work specifications and instructions. Identify the tools and raw material required for soldering components / leads. Demonstrate how to set-up the work station with all needed tools, materials, iron temperature, program etc for the specified capacitors. Perform the steps of soldering following the safety guidelines. Perform visual inspection of the assembled board and components soldered as per IPC 610 standard. Identify the issues with soldering, if any, and repeat the soldering process. Achieve soldering and inspection of targeted number of assemblies as per the quality standards. Execute daily maintenance tasks. Identify the documents related to work such as work requirement, manuals, delivery standards, company policies and so on.

UNIT-III

Workplace Safety: **03 Hours**

Identify the potential hazards and report them to authorized person. Implement proper steps to ensure a safe work place. Use safety gears while working. Apply electrical safety guidelines by using proper PPE and ESD measures as per the instructions received in the training. Use evacuation procedure and participate in fire drills. Use the safety equipment and protection devices such as Fire extinguisher and First aid equipment. Maintain proper posture while working. Participate in health sessions organized by the company like yoga, physiotherapy. Use proper equipment to handle heavy material. Comply with the daily safety instructions and the other recommended safety procedures for work before starting work, while working, after finishing work. Use proper techniques for disposal of hazardous chemicals, tools and materials by following prescribed environmental norms or as per company policy.

Note: This course is a lab-based course	
TEXTBOOKS:	
1.	The Basic Soldering Guide Handbook: Learn to Solder Electronics Successfully, Winstanley, A. Antex (Electronics) Limited, 9781500531140, 2014 CreateSpace Independent Publishing Platform.
2.	Solders and Soldering: Materials, Design, Production, and Analysis for Reliable Bonding, Manko, H.H. 9780071344173, 2001, McGraw-Hill.

TROUBLESHOOTING ELECTRICAL APPLIANCES

Course Code:	**EE2552-1**	**Course Type**	**VEC**
Teaching Hours/Week (L:T: P: S)	**0:0:2:0**	**Credits**	**03**
Total Teaching Hours	**0+0+26**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Understand working of electrical testing and protection devices
2.	Understand key elements of Home Appliances
3.	To build basic power supply module
4.	To understand working principle of power supply and stabilizer
5.	Understand domestic wiring and layout

UNIT-I

Testing Equipment & Basic control equipment:	**04 Hours**
Line tester, electronic line tester, series test lamp for single phase, parallel test lamp for single phase, electromagnetic relay, MCB (Miniature Circuit Breaker), ELCB (Earth Leakage Circuit Breaker)	
Working Principle of Home Appliances:	**06 Hours**
Working principle and troubleshooting of fluorescent and LED lamp, Iron box, fan and regulator, water pump and mixer grinder.	

UNIT-II

Rectifier Circuits and Filters:	**04 Hours**
Bridge Rectifiers, Merits, Demerits. Reactance, Capacitor, Inductor, RC, RL, RLC and their types.	
Zenar and 78XX & 79XX regulator IC:	**04 Hours**
Avalanche breakdown, Zener breakdown, Zener Characteristics. Block diagram, working and design of series /shunt regulation.	
Power supply and Stabilizer:	**02 Hours**
Block diagram, line regulation, load regulation, series & shunt regulation. Block diagram, working principle, specification, maintenance, and troubleshooting.	

UNIT-III

Electrical Wiring:	**06 Hours**
Workplace Discipline, Electrical shocks and procedure for separating person form contact with live wire, First Aid different methods of artificial respiration, Electric fire, Fire extinguishers. Introduction of wiring, selection of wiring, types of wiring, I.E. (Indian Electricity) rules of domestic wiring, testing and installation of domestic wiring, Earthing formats for electrical connections.	

Note: This course is a lab-based course

TEXTBOOKS:

1. Kleinert, Eric. Troubleshooting and Repairing Major Appliances, 2nd Ed.. United States: McGraw-Hill Education, 2007.

Humanities & Management Courses

ಆಡಳಿತ ಕನ್ನಡ (Kannada for Administration)

Course Code	HU1003-1	Course Type	MNC
Teaching Hours/Week (L:T:P:S)	1:0:0:0	Credits	0
Total Teaching Hours	15+0+0+0	CIE + SEE Marks	50+0
Prerequisite			

Teaching Department: Any Department

Course Objectives:

1.	ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡದ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡ ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡು ನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
2.	ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
3.	ಕನ್ನಡ ಭಾಷಾ ಬರೆಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗು ಅವುಗಳನಿವಾರಣೆ.
4.	ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆಸರ್ಕಾರಿ ಪತ್ರ ವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಡಿಸುವುದು.
5.	ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡ ದಪದಗಳ ಪರಿಚಯ ಮಾಡಿ ಕೊಡುವುಧು.

UNIT - I

ಲೇಖನಗಳು 1. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿ: ಹಂಪನಾಗರಾಜಯ್ಯ 2. ಕರ್ನಾಟಕದ ಏಕೀಕರಣ: ಒಂದು ಅಪೂರ್ವಚರಿತ್ರೆ - ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ 3. ಆಡಳಿತ ಭಾಷೆಯಾಗಿ ಕನ್ನಡ – ವಿತಾವಿಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನ **ಕಾವ್ಯಭಾಗ (ಆಧುನಿಕಪೂರ್ವ)** 1. ವಚನಗಳು: ಬಸವಣ್ಣ, ಅಕ್ಕಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಆಯ್ದಕ್ಕಿಮಾರಯ್ಯ, ಜೇಡರದಾಸಿಮಯ್ಯ, ಆಯ್ದಕ್ಕಿಲಕ್ಕಮ್ಮ 2. ಕೀರ್ತನೆಗಳು: ಅದರಿಂದೇನು ಫಲ ಇದರಿಂದೇನು ಫಲ - ಪುರಂದರದಾಸ 3. ತಲ್ಲಣಿಸದಿರು ಕಂಡ್ಯ ತಾಳುಮನವೆ - ಕನಕದಾಸ 4. ತತ್ವಪದಗಳು: ಸಾವಿರ ಕೊಡಗಳಸುಟ್ಟು - ಶಿಶುನಾಳಪಂಥಷರೀಫ 5. ಶಿವಯೋಗಿ: ಬಾಲಲೀಲಾ ಮಹಾಂತ ಶಿವಯೋಗಿ 6. ಜನಪದಗೀತೆ: ಬೀಸುವಪದ, ಬಡವರಿಗೆ ಸಾವ ಕೊಡಬೇಡ	**06 Hours**

UNIT – II

ಕಾವ್ಯಭಾಗ (ಆಧುನಿಕ) 1. ಮಂಕುತಿಮ್ಮನ ಕಗ್ಗ: ಡಿ.ವಿ.ಜಿ. 2. ಕುರುಡು ಕಾಂಚಾಣ: ದ.ರಾ.ಬೇಂದ್ರೆ 3. ಹೊಸಬಾಳಿನ ಗೀತೆ: ಕುವೆಂಪು 4. ಹೆಂಡತಿಯ ಕಾಗದ: ಕೆ .ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ 5. ಮಬ್ಬಿನಿಂದ ಮಬ್ಬಿಗೆ: ಜಿ. ಎಸ್. ಶಿವರುದ್ರಪ್ಪ 6. ಆಮರ ಈ ಮರ: ಚಂದ್ರಶೇಖರ ಕಂಬಾರ 7. ಚೋಮನ ಮಕ್ಕಳ ಹಾಡು: ಸಿದ್ಧಲಿಂಗಯ್ಯ **ತಾಂತ್ರಿಕ ವ್ಯಕ್ತಿಪರಿಚಯ, ಕಥೆ ಮತ್ತು ಪ್ರವಾಸ ಕಥನ** 1. ಡಾ. ಸ ಎಂ ವಿಶ್ವೇಶ್ವರಯ್ಯ – ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ: ಎ ಎನ್ಮೂರ್ತಿ ರಾವ್	**06 Hours**

2. ಯುಗಾದಿ: ವಸುಧೇಂದ್ರ 3. ಮೆಗಾನೆ ಎಂಬ ಗಿರಿಜನ ಪರ್ವತ: ಹಿ. ಚಿ. ಬೋರಲಿಂಗಯ್ಯ	
UNIT – III	
ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ 1. ಕರಕುಶಲ ಕಲೆಗಳು ಮತ್ತು ಪರಂಪರೆಯ ವಿಜ್ಞಾನ: ಕರೀಗೌಡ ಬೀಚನಹಳ್ಳಿ 2. 'ಕ' ಮತ್ತು 'ಬ' ಬರಹ ತಂತ್ರಾಂಶಗಳು ಮತ್ತು ಕನ್ನಡ ಟೈಪಿಂಗ್ 3. ಕನ್ನಡ: ಕಂಪ್ಯೂಟರ್ಶಬ್ದಕೋಶ 4. ತಾಂತ್ರಿಕ ಪದಕೋಶ: ತಾಂತ್ರಿಕ ಹಾಗೂ ಪಾರಿಭಾಷಿಕ ಕನ್ನಡ ಪದಗಳು	**03 Hours**

Course Outcomes: At the end of the course student will be able to

1.	ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡದ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡುನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
2.	ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
3.	ಕನ್ನಡ ಭಾಷಾ ಬರೆಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗು ಅವುಗಳ ನಿವಾರಣೆ.
4.	ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರ ವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
5.	ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುಧು.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1003-1.1	-	-	-	-	-	-	-	3	-	-	1	1	-	-
HU1003-1.2	-	-	-	-	-	-	-	2	-	-	1	1	-	-
HU1003-1.3	-	-	2	-	-	-	1	2	-	-	1	1	-	-
HU1003-1.4	-	-	-	-	-	-	-	1	-	-	-	-	-	-
HU1003-1.5	-	-	1	-	-	-	-	3	-	-	1	1	-	-

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	ಸಂಕ್ಷಿಪ್ತ ಕನ್ನಡನಿಗಂಟು (ಪರಿಷ್ಕೃತ), ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು.
2.	ಆಡಳಿತ ಪದಕೋಶ, ಕನ್ನಡ ಅಭಿವೃದ್ಧಿಪ್ರಾಧಿಕಾರ, ಬೆಂಗಳೂರು.
3.	ಕಾನೂನು ಪದಕೋಶ (ಪರಿಷ್ಕೃತ) ಕನ್ನಡ- ಇಂಗ್ಲಿಷ್, ಕನ್ನಡ ಮತ್ತು ಸಂಸ್ಕೃತಿ ನಿರ್ದೇಶನಾಲಯ, ಬೆಂಗಳೂರು.
4.	ಡಿ.ಎನ್. ಶಂಕರ್ಭಟ್, ಕನ್ನಡವಾಕ್ಯಗಳ ಒಳರಚನೆ, ೨೦೦೬, ಭಾಷಾಪ್ರಕಾಶನ, ಮೈಸೂರು.
5.	ಕನ್ನಡ ಭಾಷಿಕ (ಅವಿಸ್ತರ)- ಪ್ರಬಂಧ ಮತ್ತು ಆಡಳಿತ ಕನ್ನಡ, ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮುಕ್ತ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಮೈಸೂರು.
6.	ಆಡಳಿತ ಕನ್ನಡ, ಎಚ್ಚೆಸ್ಕೆ, ಚೇತನ ಬುಕ್ಹೌಸ್, ಮೈಸೂರು.

Balake Kannada (Communication in Kannada)

Course Code	**HU1003-1**	**Course Type**	**MNC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**0**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+0**
Prerequisite			

Teaching Department: Any Department

Course Objectives:

1.	The course will enable the students to cognize Kannada and communicate in basic Kannada language.

<table>
<tr><th colspan="2">UNIT - I</th></tr>
<tr><td>Basic Kannada Grammar
Personal Pronouns, Possessive Forms, Interrogative words
Possessive forms of nouns, Dubitive question and Relative nouns
Qualitative, Quantitative and Colour Adjectives, Numerals
Predictive Forms, Locative Case
Dative Cases, and Numerals
Ordinal numerals and Plural markers
Defective / Negative Verbs and Colour Adjectives
Permission, Commands, encouraging and Urging words (Imperative words and sentences)
Accusative Cases and Potential Forms used in General Communication
Helping Verbs “iru and iralla”, Corresponding Future and Negation Verbs
Comparative, Relationship, Identification and Negation Words
Different types of forms of Tense, Time and Verbs
Formation of Past, Future and Present Tense Sentences with Verb Forms
Karnataka State and General Information about the State
Kannada Language and Literature
Do's and Don'ts in Learning a Language</td><td>06 Hours</td></tr>
<tr><th colspan="2">UNIT – II</th></tr>
<tr><td>Kannada Language Script Part – 1</td><td>06 Hours</td></tr>
<tr><th colspan="2">UNIT – III</th></tr>
<tr><td>Kannada Vocabulary List & Kannada Words in Conversation</td><td>03 Hours</td></tr>
</table>

Course Outcomes: At the end of the course student will be able to

1.	Understand the parts of speech of Kannada
2.	Know the script in Kannada
3.	Able to Converse daily usages in Kannada
4.	Enrich Basic Kannada Vocabulary
5.	Have knowledge about Karnataka and its culture

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1003-1.1	-	-	-	-	-	-	-	3	-	-	1	1	-	-
HU1003-1.2	-	-	-	-	-	-	-	2	-	-	1	1	-	-
HU1003-1.3	-	-	2	-	-	-	1	2	-	-	1	1	-	-
HU1003-1.4	-	-	-	-	-	-	-	1	-	-	-	-	-	-
HU1003-1.5	-	-	1	-	-	-	-	3	-	-	1	1	-	-

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	S N Raju, “English –Kannada Rapidex Dictionary of Spoken Words”, Bengaluru
2.	D K Bharadwaj “English Kannada Standard Dictionary”, Sankeshwar Printers Pvt Ltd, Bengaluru
3.	ಮಾತಾಡುವ ಕನ್ನಡ, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು (೨೦೧೬).
4.	ಸಂಕ್ಷಿಪ್ತ ಕನ್ನಡನಿಗಂಟು (ಪರಿಷ್ಕೃತ), ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು.
5.	ಆಡಳಿತ ಪದಕೋಶ, ಕನ್ನಡ ಅಭಿವೃದ್ಧಿಪ್ರಾಧಿಕಾರ, ಬೆಂಗಳೂರು.
6.	ಕನ್ನಡ ಭಾಷಾಕೈಪಿಡಿ, ಸಂಗಮೇಶ್ಸವ ದತ್ತಿಮಠ, ರೂಪರಶ್ಮಿ ಪ್ರಕಾಶನ, ಗುಲ್ಬರ್ಗ, ೧೯೯೫.
7.	ಡಿ.ಎನ್. ಶಂಕರ್ಭಟ್, ಕನ್ನಡ ವಾಕ್ಯಗಳ ಒಳ ರಚನೆ, ೨೦೦೬, ಭಾಷಾ ಪ್ರಕಾಶನ, ಮೈಸೂರು.
8.	ಕಾನೂನು ಪದಕೋಶ (ಪರಿಷ್ಕೃತ) ಕನ್ನಡ- ಇಂಗ್ಲಿಷ್, ಕನ್ನಡ ಮತ್ತು ಸಂಸ್ಕೃತಿ ನಿರ್ದೇಶನಾಲಯ, ಬೆಂಗಳೂರು.

UNIVERSAL HUMAN VALUES

Course Code:	**HU1004-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**01**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Any Department

Course Objectives:

1.	Enable students appreciate values, skills and behaviour with an appropriate understanding of 'Self' to attain sustained happiness and prosperity with right aspirations of life.
2.	Develop a holistic perspective among the students towards physical needs and prosperity of life.
3.	Develop a holistic approach and understand the importance of co-existence and living in harmony ensuring mutually fulfilling interaction with the society and nature.
4.	Strengthening of self-reflection.
5.	Development of commitment and courage to act.

UNIT-I

Need, Basic Guidelines, Content and Process for Value Education	**06 Hours**

Self-Exploration; 'Natural Acceptance' and Experiential Validation; Continuous Happiness and Prosperity; Right understanding, Relationship and Physical Facility; Understanding Happiness and Prosperity - living in harmony at various levels**.**

UNIT-II

Understanding Harmony in the Human Being, Family and Society	**06 Hours**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body; the needs of Self ('I') and 'Body'; the Body as an instrument; Holistic perspective of Physical needs and Prosperity; Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

UNIT-III

Whole existence as Coexistence: Implications of the above Holistic Understanding of Harmony and Professional Ethics	**03 Hours**

Understanding the harmony in the Nature and Existence; Existence as Co-existence, Holistic perception of harmony at all levels of existence; Natural acceptance of human values, Professional Ethics

Course Outcomes: At the end of the course student will be able to

1.	Have a better self-exploration and understanding with a capacity to identify the priorities of life.
2.	Generate Sustainable solution to problems with focus on human values and value-based living.
3.	Have an understanding of the Holistic perspective of Physical needs
4.	Understand and practice living in harmony, co-existence and natural acceptance
5.	Exhibit Professional Ethics in the workplace

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
HU1004-1.1	-	-	-	-	-	-	-	3	-	-	2	2	-	-
HU1004-1.2	-	-	-	-	-	-	-	2	-	-	2	2	-	-
HU1004-1.3	-	-	2	-	-	-	1	2	-	-	2	2	-	-
HU1004-1.4	-	-	-	-	-	-	-	1	-	-	-	-	-	-
HU1004-1.5	-	-	1	-	-	-	-	3	-	-	2	2	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics", Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1. A Nagaraj, "Jeevan Vidya: Ek Parichaya", Jeevan Vidya Prakashan, Amarkantak, 1999
2. A.N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth"
5. E. F Schumacher, "Small is Beautiful"
6. Cecile Andrews, "Slow is Beautiful"
7. J C Kumarappa, "Economy of Permanence"
8. Pandit Sunderlal, "Bharat Mein Angreji Raj"
9. Dharampal, "Rediscovering India"
10. Mohandas Karamchand Gandhi, "Indian Home Rule"
11. Maulana Abdul Kalam Azad, "India Wins Freedom"
12. Romain Rolland, "Vivekananda"
13. Romain Rolland, "Gandhi"

ESSENCE OF INDIAN CULTURE

Course Code:	**HU1005-1**	**Course Type:**	**HEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+0**

Teaching Department: Humanities

Course Objectives:

1.	To facilitate students with the concepts of Indian Culture and to make them understand the roots of knowledge system.
2.	To acquaint students with Indian Culture and inculcate an ability to analyze it.
3.	To apply various approaches for the enhancement of living ideals based on Indian traditional knowledge.

UNIT-I

Introduction to Traditional Knowledge — **6 Hours**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge and its characteristics, Traditional Knowledge vis-a-vis Indigenous Knowledge, Traditional Knowledge vis-a-vis Western Knowledge

UNIT-II

Significance of Traditional Knowledge — **6 Hours**

Value of Traditional Knowledge in global economy, Role of Government in harnessing Traditional Knowledge, Traditional medicine system, Traditional Knowledge in agriculture. food and healthcare.

UNIT-III

Holistic Healthcare for Human Well-being — **3 Hours**

Definition of Ayurveda, Ayurveda for Life, Health and Well-being, Introduction to principles of Ayurvedic healing and Astanga Ayurveda.

Course Outcomes: At the end of the course student will be able to

1.	Identify the concept of Traditional Knowledge and its importance.
2.	Explain the need for and importance of protecting Traditional Knowledge.
3.	Illustrate the various enactments related to Traditional Knowledge.
4.	Familiarize the importance of Holistic Healthcare.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1005-1.1	-	-	-	-	-	-	-	-	-	2	2	3	-	-
HU1005-1.2	-	-	-	-	-	-	-	-	-	3	2	3	-	-
HU1005-1.3	-	-	-	-	-	-	-	-	-	3	2	3	-	-
HU1005-1.4	-	-	-	-	-	-	-	-	2	2	2	2	-	-
HU1005-1.5	-	-	-	-	-	-	-	-	1	2	2	2	-	-

1: Low 2: Medium 3: High

REFERENCES:

1.	Jha, A., "Traditional Knowledge System in India", Atlantic Publishers, 2002.
2.	Kapoor, K., & Danino, M., "Knowledge Traditions and Practices of India", 2012.
3.	Kapil Kapoor, Michel Danino, "Knowledge Traditions and Practices of India", Medknow Publications and Media.
4.	Jha, R.N., "Science of Consciousness Psychotherapy and Yoga Practices", Delhi: Vidyanidhi Prakashan, 2015.
5.	TEDx Talks. (2015, February 6). Unleashing the Power of Traditional Medicine	Dr. Arvind Singh [Video file]. Retrieved from https://www.youtube.com/watch?v=LZP1StpYEPM

INTELLECTUAL PROPERTY RIGHTS

Course Code:	**HU1006-1**	**Course Type:**	**HSMC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Any Department

Course Objectives:

1.	Enhancing the learning system through innovation and creative thinking skills for effective business process.
2.	Acquaint with special challenges of starting new ventures.
3.	Facilitate Entrepreneurial skills in recognizing opportunities for competitive advantages.
4.	Provide insights of financial aspects in planning and executing a business plan.
5.	Ascertain the role of IPR to protect innovations and intangible assets.

UNIT-I

Intellectual Property Rights (IPR) — **6 Hours**

Introduction to IPR: Business Perspective, IPR in India – Genesis and Development, International Context, Concept of IP Management, Uses in marketing

UNIT-II

Types of Intellectual Property — **6 Hours**

Patent - Procedure, Licensing and Assignment, Infringement and Penalty, Trademark, Example of Trademarks - Domain name, Geographical Indications, Copyright, Industrial Designs, Class Discussion - Major Court Cases regarding violation of Patents

UNIT-III

Basic Tenets of Information Technology Act, 2000 — **3 Hours**

IT Act – Introduction, E-Commerce and Legal Provisions, E- Governance, Digital signature and Electronic Signature, Cybercrimes

Course Outcomes: At the end of the course student will be able to

1.	Comprehend Innovation, its process and sources.
2.	Apply the process of building an innovative organization.
3.	Recognize the characteristics of different types of Entrepreneurships
4.	Formulate a business plan based on a business idea in Technology.
5.	Interpret basic tenets of Information Technology Act, 2000.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1006-1.1	-	-	-	-	-	-	-	-	-	2	-	3	-	-
HU1006-1.2	-	-	-	-	-	-	-	-	-	3	-	3	-	-
HU1006-1.3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
HU1006-1.4	-	-	-	-	-	-	-	-	2	2	-	2	-	-
HU1006-1.5	-	-	-	-	-	-	-	-	1	2	-	2	-	-

1: Low 2: Medium 3: High

REFERENCES:	
1.	Tidd, J., & Bessant, J., "Managing Innovation: Integrating Technological, Market and Organizational Change", Wiley, 2021.
2.	Case Study Materials: To be distributed for Class Discussion
3.	Reddy, G. B., "Intellectual Property Rights and the Law", Gogia Law Agency, 2012.
4.	Wadehra, B. L., "Law relating to Intellectual Property", Universal Law Publishing Co., 2011.
5.	Narayanan, P., "IPR", Eastern Law House Private Ltd, 2017.

SOCIAL CONNECT AND RESPONSIBILITY

Course Code:	**HU1007-1**	**Course Type:**	**AEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Any Department

Course Objectives:

1.	Understand Rural Society
2.	Acquire the knowledge about Rural Economy
3.	Know the working of rural administration
4.	Familiarize the different rural schemes of Governance

UNIT-I

Appreciation of Rural Society	**3 Hours**

Rural Society, Caste and Gender relations, Rural values, Nature and Resources, Rural infrastructure.

Understanding Rural Economy & Livelihood	**3 Hours**

Agriculture, Farming, Landownership, Water Management, Animal Husbandry, Non-Farm Livelihoods And Artisans, Rural Entrepreneurs.

UNIT-II

Rural Institutions	**3 Hours**

Traditional Rural Organizations, Self-help Groups, Panchayat Raj Institutions - Gram Sabha, Gram Panchayat, Standing Committees

Rural Development Programmes	**3 Hours**

History of Rural Development in India, Current National Programmes - Sarva Shiksha Abhiyaan, Beti Bachao – Beti Padhao, Ayushmaan Bharath, Swachh Bharath, PM Awaas Yojana, Skill India, Decentralised Planning, NRLM, MNREGA

UNIT-III

Corporate Social Responsibility (CSR)	**3 Hours**

Global Guidelines on CSR, Growing Importance of CSR, CSR in India

Course Outcomes: At the end of the course student will be able to

1.	Comprehend Rural Society and its Economy
2.	Identify the working of Rural Administration and different rural schemes
3.	Grasp the working of Corporate Social Responsibility

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1007-1.1	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1007-1.2	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1007-1.3	-	-	-	-	-	-	-	-	-	-	2	3	-	-

1: Low 2: Medium 3: High

REFERENCES:

1.	UGC., “Unnat Bharat Abhiyan”, 2020
2.	Agarwal, S.K., “Corporate Social Responsibility in India”, SAGE Publication, 2008.
3.	Unnat Bharat Abhiyan. (n.d.). Unnat Bharat Abhiyan Brochure. Retrieved from https://unnatbharatabhiyan.gov.in/app/webroot/files/brochure.pdf

LIFE SKILLS FOR ENGINEERS

Course Code:	**HU1008-1**	**Course Type:**	**AEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Understand Time Management, Managing Information Overload, Coping with Peer pressure and Stress Management
2.	Familiarize the Science behind Personal Health Management and Addictions
3.	Appreciate the importance of cultivating good hobbies, need for forming good habits and discarding bad habits and holding difficult conversations during crises
4.	Comprehend the importance of Creative Thinking, Continuous and Lifelong Learning, Collaboration and Team Work
5.	Equip them to excel in real work environment proactively

UNIT-I

Introduction to Life Skills — **3 Hours**

Meaning and Importance of Life Skills, Competitive Job market, Fast paced changes in Technology, Proliferation of Electronic Gadgets and harmful online content.

Time Management

Introduction to Time Management, Impulsive Behaviour vis-a-vis goal Directive Behaviour, Time log, Information Overload and coping with Information & Communication Technology (ICT) Revolution; Proliferation of Electronic Media; Exponential growth in online content; Impact of Information Overload on human brain

Science behind Personal Health Management — **3 Hours**

Ignorance in Society on health issues, World Health Organization (WHO) - Definition of Health, Human Evolution, Importance of physical work for human body & mind, Dangers of sedentary lifestyle, Germ diseases versus Lifestyle diseases, Integrating physical exercise into daily life

Science behind Addictions

Addiction - Meaning, Neurology and Hormonal basics of Addictive Behaviour, How addictions are formed; Harmful effects of addictions on Physical and Mental Health, Recognizing addictions in oneself, Coming out of addictions

UNIT-II

Need for cultivating good hobbies — **3 Hours**

Need for Hobbies in maintaining Work-Life Balance; how hobbies help in maintaining good physical and mental health, Various Hobbies

Habits

Difference between hobbies & habits, Cultivating good habits & discarding bad habits: Role of habits for a successful life, How habits form; Analyzing one's own habits; Recognizing useless & harmful habits, Cultivating & Sustaining useful habits

Peer pressure and How to cope with it — **3 Hours**

Human being as a Social Animal, Physical Pain & Social Pain; Awareness of Harmful Social Pressure, Role of Prefrontal Cortex in Judgement and Decision Making, why teenagers are vulnerable to peer pressure, strategies to overcome harmful peer pressure

Stress Management

Stress, Types of Stress, Fight & Flight Response of Humans; Harmful effects of chronic stress; Symptoms of Poor Coping Skills of Stress, Stress & Psychiatric problems, Easy coping strategies for stress

UNIT-III

Continuous & Lifelong Learning	**3 Hours**
Accelerated change in Technology Landscape, Shorter Life Cycles of Technologies, Need for Continuous Learning of other skills **Team Working Skills & Collaboration** Team Work – Meaning, Skills and Relevance, Importance of Collaboration to succeed in one's own career, How to be a good team member	

Course Outcomes: At the end of the course student will be able to

1.	Apply the concept of Time Management, cope with Information Overload and withstand harmful peer pressure
2.	Comprehend the need to stay away from addictions by realizing the biological basis behind these concepts
3.	Develop good hobbies to maintain ideal work-life balance
4.	Develop the aptitude for finding creative solutions to problems and realize the importance of continuous and lifelong learning
5.	Demonstrate positive and progressive abilities

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1008-1.1	-	-	-	-	-	-	-	-	-	2	1	3	-	-
HU1008-1.2	-	-	-	-	-	-	-	-	-	3	2	3	-	-
HU1008-1.3	-	-	-	-	-	-	-	-	-	3	1	3	-	-
HU1008-1.4	-	-	-	-	-	-	-	-	2	2	1	2	-	-
HU1008-1.5	-	-	-	-	-	-	-	-	1	2	1	2	-	-

1: Low 2: Medium 3: High

REFERENCES:

1.	Lieberman, D.E., "The Story of the Human Body", Pantheon Books, 2013.
2.	Ratey, J.J., "Spark. Little Brown Spark", 2013.
3.	De Bono, E., "Creative Thinking", Penguin UK, 2016.
4.	Pachter, B., "The Power of Positive Confrontation", Da Capo Lifelong Books, 1999.
5.	Duhigg, C., "The Power of Habit", Random House Trade Paperbacks, 2012.
6.	Sharma, S., & Mishra, B., "Communication Skills for Engineers and Scientists", PHI Learning, 2009.
7.	Tracy, B., "Time Management", AMACOM, 2014.

INDIAN KNOWLEDGE SYSTEMS

Course Code:	**HU1009-1**	**Course Type:**	**HEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+0**

Teaching Department: Humanities

Course Objectives:

1.	Enhance knowledge about the History of Ancient India and Rich Culture of the country
2.	Gain an introduction to ancient Indian Engineering Technology and Architecture
3.	Familiarize Indian indigenous wisdom in Modern scientific paradigm
4.	Understanding the Scientific Value of the Traditional Knowledge of our country
5.	Comprehend and compare the Ancient and Current Knowledge Systems

UNIT-I

Indian History — **6 Hours**

History - Land, Environment, and people in Ancient India; Ancient Education System, Takṣaśilā and Nālandā University, Hunting to Agriculture; Introduction to Vedas and Upanishads; Great Indian Epics; Indian Festivals

UNIT-II

Engineering, Technology, and Architecture — **6 Hours**

Pre-Harappan and Sindhu Valley Civilization, Laboratory and Apparatus, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Engineering Science and Technology in the Vedic Age and Post-Vedic Records, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology

UNIT-III

Science, Astronomy, and Mathematics — **3 Hours**

Concept of Matter, Life and Universe, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimāna: Aeronautics, Vedic Cosmology and Modern Concepts, History and Culture of Astronomy, Sun, Earth, Moon, Eclipses, Rotation of Earth, Concepts of Zero and Pi, Number System, Pythagoras Theorem and Vedic Mathematics.

Course Outcomes: At the end of the course student will be able to

1.	Understand the relevance of studying history
2.	Comprehend the origin of Vedas and epics
3.	Realize the scientific value of the Traditional Knowledge of India
4.	Converting the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm
5.	Preserve and disseminate Indian Knowledge Systems in Research and Societal applications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1009-1.1	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1009-1.2	-	-	-	-	-	-	-	-	-	-	3	3	-	-
HU1009-1.3	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1009-1.4	-	-	-	-	-	-	-	-	-	-	2	2	-	-
HU1009-1.5	-	-	-	-	-	-	-	-	-	-	2	2	-	-

	1: Low 2: Medium 3: High
REFERENCES:	

1.	Tripati, R.S., “History of Ancient India”, Motilal Banarsidass, 1942.
2.	Mahajan, V.D.. “Ancient India”, S. Chand and Company, 1985.
3.	Ramasubramanian, K., & Srinivas, M.D., “Development of Calculus in India”, 2010.
4.	Ramasubramanian, K., Srinivas, M.D., & Sriram, M.S., “The Traditional Indian Planetary Model and its Revision by Nilakantha Somayaji”, 2011.
5.	Srinivas, M.D., “Proofs in Indian Mathematics”, Hindustan Book Agency, 2005.
6.	Srinivas, M.D., “The Algorithmic Approach of Indian Mathematics”, 2015.
7.	Srinivas, M.D. “Indian Tradition of Science: An Introductory Overview”, 2016.
8.	Rahika, M., & Balasubramanian, A.V., “Ayurvedic Principles of Food and Nutrition”, Part 1. Lok Swasthya Parampara Samvardhan Samithi, 1990.

ENHANCING SELF-COMPETENCE

Course Code:	**HU2001-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**2:0:0:0**	**Credits**	**02**
Total Teaching Hours	**25+0+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Humanities

Course Objectives:

1.	Introspect and learn about oneself.
2.	Develop professional writing skills.
3.	Acquaint with the various social behaviour and etiquette.
4.	Apply the techniques of fundamental communication skills.
5.	Develop necessary techniques for formal presentations.

UNIT-I

Personality Traits	**09 Hours**
Types & Kinds of personality, Ways to Identify Self (SWOT Analysis, Johari Window), Concepts of Self-Management and Self-Motivation	
Effective Communication Skills	
One-way and Two-way Communication, Interpersonal & Social Skills	

UNIT-II

Social Behaviour and Cultural Etiquette	**09 Hours**
Time Management, Personal Grooming, Making Small Talk, Customs & Manners	
Professional Presentation Techniques	
Formal Presentation, Sensitivity towards multi-cultural workspaces	

UNIT-III

Job-Related Communication	**08 Hours**
Resume & Cover Letter, Formal E-mails, Framing Requests, Greetings, Salutations, Close	

Course Outcomes: At the end of the course student will be able to

1.	Understand the importance of human conduct.
2.	Demonstrate knowledge of theory and competence in office communication.
3.	Develop and assess various types of communication.
4.	Be Familiar with the current practices of social behaviour.
5.	Prepare and deliver presentation appropriate for the workplace.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU2001-1.1	-	1	-	-	-	2	2	-	3	-	-	-	-	-
HU2001-1.2	-	-	-	-	-	-	-	3	2	1	-	1	-	-
HU2001-1.3	-	-	2	-	-	2	2	2	-	-	-	2	-	-
HU2001-1.4	-	3	-	-	-	-	-	-	2	3	2	-	-	-
HU2001-1.5	2	2	-	1	-	-	-	-	2	-	-	-	-	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	R R Gaur, R Sangal, G P Bagaria, “Human Values and Professional Ethics”, Excel Books, New Delhi, 2010.
2.	Ronald B Adler and Jeanne Marquardt Elmhorst, "Communicating at Work – Principles and Practices for Business and the Professions", 6th Edition, McGraw Hill College.
3.	Stephen R. Covey, "The 7 Habits of Highly Effective People", Simon & Schuster, 1994.
4.	Sarvesh Gulati, "Corporate grooming and Etiquette", Rupa Publications India Pvt. Ltd., 2010.
5.	Fred. Luthans, "Organizational Behaviour", McGraw Hill International.
6.	Tom Rath, “Strengths Finder 2.0", Gallup Press, 2007.
7.	M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw- Hill, 2005.
8.	Stephen P. Robbins, "Organizational Behaviour", Prentice Hall.
9.	Dale Carnegie, "How to Win Friends and Influence People", Gallery Books, 2016.

MANAGEMENT & ENTREPRENEURSHIP

Course Code:	**MG1003-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Teaching Department: Any Department

Course Objectives:

1.	Explain fundamentals management functions of a manager. Also explain planning and decision making processes.
2.	Explain the organizational structure, staffing and leadership process.
3.	Explain understanding of Entrepreneurships and Entrepreneurship development process.
4.	Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur.
5.	Summarize the preparation of project report, need significance of report. Also to explain about industrial ownership

UNIT-I	**15 Hours**
Management	
Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as art or science, art or profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches - Modem management approaches.	
Planning	
Nature, importance and purpose of planning process objectives - Types of plans (meaning only) - Decision making, Importance of planning - steps in planning & planning premises - Hierarchy of plans.	
Organizing and Staffing	
Nature and purpose of organization, Principles of organization – Types of organization-Departmentation Committees-Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning only) Nature and importance of staffing-Process of Selection & Recruitment (in brief).	
Directing	
Meaning and nature of directing Leadership styles, Motivation, Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of coordination.	
Controlling	
Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).	

UNIT-II	**15 Hours**
Entrepreneur	
Meaning of Entrepreneur; Evolution of .the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.	
Small scale industries	
Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI, Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization	

on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only).

Institutional support

Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

UNIT-III	10 Hours

Preparation of project

Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of. Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

Industrial ownership

Definition and meaning of Partnership, Characteristics of Partnership, Kinds of Partners, Partnership Agreement or Partnership Deed, Registration of Partnership Firm, Rights, Duties and Liabilities of Partners, Advantages and Disadvantages of Partnership, Sole proprietorship, Features, Scope Advantages and Disadvantages of Sole Proprietorship.

Course Outcomes: At the end of the course student will be able to

1.	Explain management functions of a manager. Also explain planning and decision making processes.
2.	Explain the organizational structure, staffing and leadership processes.
3.	Understanding of Entrepreneurships and Entrepreneurship development process.
4.	Illustrate Small Scale Industries, various types of supporting agencies and financing available for an entrepreneur.
5.	Summarize the preparation of project report, need significance of report. Also to explain about industrial ownership.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MG1003-1.1	3	-	-	-	-	-	-	2	2	-	3	-	-	1
MG1003-1.2	3	-	-	-	-	-	-	2	2	-	3	-	-	2
MG1003-1.3	3	-	-	-	-	-	-	2	2	-	3	-	-	2
MG1003-1.4	3	-	-	-	-	-	-	2	2	-	3	-	-	2
MG1003-1.5	3	-	-	-	-	-	-	2	2	-	3	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. P. C. Tripathi, P.N. Reddy, "Principles of Management", Tata McGraw Hill.
2. Vasant Desai, "Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House.
3. Poornima. M. Charantimath, "Entrepreneurship Development",Small Business Enterprises – Pearson Education - 2006 (2 & 4).

REFERENCE BOOKS:

1. Robers Lusier, "Management Fundamentals - Concepts, Application, Skill Development", Thomson.
2. S. S. Khanka,"Entrepreneurship Development" - S. Chand & Co. New Delhi.
3. Stephen Robbins, "Management", Pearson Education/PHI - 17thEdition, 2003.

FINANCIAL MANAGEMENT

Course Code:	**MG1002-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Any Department

Course Objectives:

1.	Develop basic financial management knowledge essential to make a managerial career in professional life.
2.	Impart some of the crucial and basic skills required to work in the area of budgeting, investment and financial decision making.
3.	Enable in making a right decisions on selection of projects for investment.
4.	Understand the basics of finance and financial markets, project evaluation and selection.

UNIT-I

Time Value of Money — **15 Hours**

Financial Management: Concepts and Meaning – Introduction to Finance; Objectives of Financial Management; Profit Maximization; EVA; Changing Role of Financial Managers.
Time Value of Money: Techniques and Applications of Compounding and Discounting.

UNIT-II

Capital Budgeting and Working Capital — **15 Hours**

Capital Budgeting (Investment Evaluation Techniques): Payback Period Method; Present Worth Method; Annual Worth Method; Profitability index method; Estimation of IRR.
Cost of Capital: Sources of various Types of Capital; Cost of Debenture Capital; Cost of Preferential Capital; Cost of Term Loans; Cost of Equity Capital.
Working Capital: Factors influencing Working Capital Requirements.

UNIT-III

Inventory Management and Break Even Analysis — **9 Hours**

Inventory Management: Techniques of Inventory Management and Control – EOQ, ABC Analysis, Just-in-Time (JIT) System
Break Even Analysis: Estimation of Break-Even Point and Values.

Course Outcomes: At the end of the course student will be able to

1.	Describe the basic financial management skills required for a professional.
2.	Explain techniques and applications of compounding and discounting and calculate compounded/discounted amount for the given proposal.
3.	Evaluate the given investment option by capital budgeting techniques.
4.	Describe the basics of cost of capital and working capital. Determine the cost of capital for the given investment option.
5.	Describe the basics of inventory management and calculate the economic order quantity and reorder point for the given conditions. Calculate breakeven point for the given manufacturing setup.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
MG1002-1.1	3	-	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.2	1	3	-	-	-	-	-	-	1	1	-	1	-	-	-

MG1002-1.3	2	3	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.4	2	3	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.5	1	3	-	-	-	-	-	-	1	1	-	1	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. M Y Khan, P K Jain , "Financial Management – Text, Problems & Cases",7th Edition, 2015; McGraw Hill Education (India) Pvt. Ltd, New Delhi.
2. I M Pandey, "Financial Management", 11th Edition, 2015; Vikas Publishing House Pvt. Ltd. (UP) India.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa, "Engineering Economics", 4th Edition, Tata McGraw Hill Edition.

REFERENCE BOOKS:

1. Prasanna Chandra, "Financial Management", 6th Edition, 2004; Tata McGraw Hill Publishing Company Ltd, New Delhi.
2. S. D. Sharma, "Operation Research" , Kedar Nath Ram Nath Publishers, 2015.

EMPLOYABILITY SKILL DEVELOPMENT

Course Code:	**UM1003-1**	**Course Type**	**MNC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**01**
Total Teaching Hours	**15+00+00**	**CIE + SEE Marks**	**100**
Prerequisite			

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To explain the students the necessity of clearing the aptitude tests irrespective of the written test is for jobs or higher education.
2.	To assess the readiness of the students to appear for the aptitude test and assisting them to better it if already ready, else train them.
3.	To evaluate the understanding of the students in answering quantitative multiple-choice questions and guide them to improve it.
4.	To evaluate the preparedness of the students to answer the analytical and logical questions.
5.	To evaluate the quality of the students with regard to their professional language grammar, vocabulary and communication skills.

UNIT-I

Quantitative	**06 Hours**

Numbers (Odd, even, H.C.F & L.C.M, Square roots & cube roots, Average, Percentage), Ratios & Proportions, Partnership, Time & work, Pipes & Cistern, Speed, Problems on trains, Problems on boats & streams, Allegation & Mixtures.

UNIT-II

Analytical/logical	**05 Hours**

Numerical logic (next number in series, odd man out), Coded language, Syllogism, Direction (N-E-W-S), Seating arrangement, Blood relations, Statement & Conclusion

UNIT-III

Verbal	**04 Hours**

Vocabulary (root words, prefix, suffix, synonyms, antonyms), One word substitution, Idiom/phrases, Sentence completion, Active & Passive voice, Direct and indirect speech.

Course Outcomes: At the end of the course student will be able to

1.	Answer the quantitative multiple-choice questions.
2.	Analyse the analytical and logical questions.
3.	Improve the professional language grammar, vocabulary and communication skills.
4.	Clear the aptitude tests of any employer or higher educational institution.
5.	Advance in the chosen field of interest by appending aptitude skills with the technical skills.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
UM1003-1.1	3	3	-	-	-	-	-	-	2	2	1	-	-	-
UM1003-1.2	3	3	-	-	-	-	-	-	2	2	1	-	-	-
UM1003-1.3	3	3	2	-	-	-	-	-	2	2	1	-	-	-
UM1003-1.4	3	3	2	-	-	-	-	-	2	2	1	-	-	-
UM1003-1.5	3	3	2	-	-	-	-	-	2	2	1	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R S Aggarwal, "Quantitative Aptitude for Competitive Examinations".
2. R S Aggarwal, "A modern approach to verbal and non-verbal reasoning".

REFERENCE BOOKS:

1. Bharath Patodi & Aditya Choudhary, "Verbal Ability & Comprehension".
2. Shakuntala Devi, "Joy of numbers".
3. Shakuntala Devi, "More puzzles to puzzle you".

E Books / MOOCs/ NPTEL

1. https://www.indiabix.com
2. https://www.faceprep.in

University Core Courses

Internship-I			
Course Code	**UC1001-1**	CIE Marks	**100**
Teaching Hours/Week (L: T: P: S)	**-**	SEE Marks	-
Total Hours of Pedagogy	80-90 Hours (During I/II semesters)	Total Marks	**100** (Evaluation in I/II/III Semester and grades earned shall be included in IV Semester grade card)
Credits	**2**	Exam Hours	--

Course objective

1. This course is meant to provide students an opportunity to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the institution; contribution at incubation/ innovation /entrepreneurship cell of the institution; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research projects within the institution and Participation in all the activities of Institute's Innovation Council.

Activities: Refer Appendix B - 3.4 for details

Course outcomes

1. Experience the working in Inter / Institutional activities
2. Work in teams and communicate efficiently both written and oral.
3. Develop the ability to do work in different activities, which will provide the necessary understanding and contribute to the same and provide a foundation to undergo higher level training in subsequent internships.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
UC2001-1.1	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**-**
UC2001-1.2	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**-**
UC2001-1.3	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**	**-**

1: **Low** **2: Medium** **3: High**

INTERNSHIP-II

Course Code:	**UC2001-1**	**Course Type**	**UCC**
Teaching Hours/Week (L: T: P: S)	**-**	**Credits**	**08**
Total Teaching Hours	**-**	**CIE + SEE Marks**	**50+50**
Prerequisite			

Course Objectives:

1.	This course is meant to provide students an avenue to understand the work environment, ethics and practices in an industry/organization and take up assignments/jobs in the future.

Course Outcomes: At the end of the course student will be able to

1.	Analyse and Develop technical solutions for a specific problem that is assigned to them.
2.	Communicate ideas that are developed through brainstorming, presentation and prepare a report.
3.	Understand and inculcate industry practices in their professional career.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO↓**	
↓ Course Outcomes													**1**	**2**
UC2001-1.1	3	2	-	-	1	1	-	-	2	3	1	-	1	1
UC2001-1.2	3	2	-	-	1	1	-	-	2	3	1	-	1	1
UC2001-1.3	3	2	-	-	1	1	-	-	2	3	1	-	1	1

1: Low 2: Medium 3: High

MAJOR PROJECT

Course Code:	**UC3001-1 & UC3002-1**	**Course Type**	**UCC**
Teaching Hours/Week (L: T: P: S)	**09**	**Credits**	**10**
Total Teaching Hours:52	**-**	**CIE + SEE Marks**	**100+100**
Prerequisite			

Course Objectives:

1.	The student should complete a project using the knowledge gathered from the courses successfully completed.
2.	Conceptual development of a new idea in the field of Electrical and Electronics Engineering

Students will carry out a detailed project in Electronics either singly or in small groups to show case the extent of knowledge gained during the regular classes in the relevant and useful applications on the subject of electrical and electronic circuits, systems, using either or both hardware and software.

It is recommended that a group of 3-4 students be guided by one faculty member during this period.

Assessment Details (both CIE and SEE)

CIE procedure for project phase II is same as that of project phase I

Semester End Examination:

SEE procedure:
i)Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

SCHEME OF EVALUATION:
Project demonstration, Viva voce
Total marks: 100 Marks

The distribution of marks shall be proportioned based on the type of the project and it is based on fulfilling the following requisites.

The evaluation of students is proposed to be done by internal faculty with active involvement of industrial personnel. The evaluation may be based on following criteria:

- Punctuality and Attendance ¨ Interpersonal relations
- Sense of Responsibility
- Clarity of concepts, principles and procedures
- Self-expression/communication skills
- Report Writing Skills
- Creativity/conceiving new and unusual ideas
- Problem-solving skills

At the end of the project work course students are required to submit a working model of the equipment they have designed and developed or if it is a theoretical or experimental work, they are expected to study a detailed analysis and findings from their work.

Course Outcomes: At the end of the course student will be able to

1.	Design and model a system based on the requirements; implement, test and analyse the performance of the system.
2.	Record and document the work done.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
UC3001-1/UC3002-1.1	3	2	2	3	3	2	2	2	3	1	3	3	3	3	3
UC3001-1/UC3002-1.2	1	1	1	1	1	1	1	1	3	3	1	3	3	3	3

1: Low 2: Medium 3: High

Open Elective Courses

LIST OF OPEN ELECTIVE COURSES

Sl No.	Department	Course Codes	Open Elective Courses
1	BT	BT1501-1	Bio Fuel Engineering
2	BT	BT1502-1	Solid Waste Management
3	CS	CS2501-1	Fundamentals of AI and ML
4	CS	CS2502-1	Introduction to Data Structures
5	CV	CV2501-1	Disaster Management
6	CV	CV2502-1	Environmental Hygiene, Sanitation and Waste Management
7	CV	CV2503-1	Environmental Impact Assessment
8	CV	CV2504-1	Introduction to Geoinformatics
9	CY	CY2501-1	Corrosion Science (Only for CV and ME)
10	CY	CY2502-1	Natural Products Chemistry (Only For BT)
11	EC	EC1501-1	Artificial Neural Network Systems
12	EC	EC1502-1	Introduction to MATLAB Programming: A Hands-on Approach (only for CV and BT)
13	EC	EC1503-1	Robotics
14	EC	EC2501-1	Consumer Electronics
15	EC	EC2502-1	PCB Design and Fabrication
16	EC	EC2503-1	Space Technology and Applications
17	EE	EE2501-1	Battery Management System
18	EE	EE2502-1	Biomedical Instrumentation
19	EE	EE2503-1	Electric Vehicle Technology
20	EE	EE2504-1	Fundamentals of PLC and its applications
21	EE	EE2505-1	Motors and Motor Control Circuits
22	EE	EE2506-1	Non-Conventional Energy sources
23	HU	HU1501-1	Elements of Yoga
24	HU	HU1502-1	Intellectual Property Rights
25	HU	HU1503-1	Introduction to German Language
26	HU	HU1504-1	Introduction to Japanese Language
27	HU	HU1505-1	National Cadet Corps: Organization, Functions & Capabilities
28	HU	HU1506-1	Overview of Indian Culture
29	HU	HU1507-1	Philosophy
30	HU	HU1508-1	Principles of Physical Education
31	HU	HU1509-1	Indian Culture – Dance *
32	HU	HU1510-1	Indian Culture – Music *
33	HU	HU1511-1	Engineering Ethics *
34	HU	HU1512-1	Art of Communication and Interpersonal Skills*
35	HU	HU2501-1	Common sense and Critical Thinking
36	HU	HU2502-1	Linguistics & Language Technology

37	IS	IS2501-1	Introduction to Cyber Security (except EC, EE, AM, AD, CC, CS, IS)
38	IS	IS2502-1	Python Application Programming
39	IS	IS2503-1	Software Engineering Practices
40	IS	IS2504-1	Web technologies
41	MA	MA1501-1	Graph Theory (for BT, CV, EC, EE, ME and RI)
42	MA	MA1502-1	Number Theory
43	MA	MA3501-1	Linear Algebra (for BT, CV, EE, ME and RI)
44	ME	ME1501-1	Automotive Engineering
45	ME	ME1502-1	Industrial Pollution Control
46	ME	ME1503-1	Sustainable Development Goals
47	ME	ME1504-1	Technology Innovation
48	MG	MG1501-1	Human Resource Management
49	MG	MG1502-1	Management Accounting and Control Systems
50	MG	MG1503-1	Operations and Quality Management
51	MG	MG1504-1	Organizational Behaviour
52	MG	MG1505-1	Taxation for Engineers
53	MG	MG1506-1	Working Capital Management
54	PH	PH2501-1	Nanotechnology
55	PH	PH2502-1	Optoelectronic Devices (EC, EE, CSE, ISE, AM and CC branches)
56	RI	RI2501-1	Autonomous Mobile Robots
57	RI	RI2502-1	Medical Robotics (for all except AI)
58	RI	RI2503-1	PLC Control of Hydraulic and Pneumatic Circuits (for all except AI)

*** For students admitted under Twinning Program**

BIOFUEL ENGINEERING

Course Code:	**BT1501-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Biotechnology

Course Objectives:

1.	To learn the fundamental concepts of biofuels, types of biofuels, their production technologies.
2.	To learn the concepts of feedstock utilization and energy conversion technologies.

UNIT-I

Liquid Biofuels **15 Hours**

Description and classification of Biofuels; Primary biomass: Plant Materials-Woody biomass, Lignocellulosic and agroindustrial by-products, starchy and sugary crops. Secondary biomass: Waste residues and co-products- wood residues, animal waste, municipal solid waste. Biomass production for fuel – algal cultures, yeasts (Lipid and carbohydrate).

Production of biodiesel: Sources of Oils – edible and non-edible; Esterification and Transesterification. Free fatty acids; saponification; Single step and two step biodiesel production. Catalysts for biodiesel production – homogeneous (alkali/acidic) and heterogeneous; Lipase mediated process. General procedure of biodiesel production and purification Quality Control Aspects: GC analysis of biodiesel, fuel property measurements, ASTM (D-6751) and Indian standards (IS15607). Algal Biodiesel production.

Production of Bioethanol: Bioethanol production using Sugar; Starch and Lignocellulosic feedstocks; Pretreatment of lignocellulosic feed stock

UNIT-II

Biohydrogen and Microbial Fuel Cells **15 Hours**

Enzymes involved in H_2 Production; Photobiological H_2 Production: Biophotolysis and Photo fermentation; H_2 Production by Fermentation: Biochemical Pathway, Batch Fermentation, Factors affecting H_2 production, Carbon sources, Detection and Quantification of H_2. Reactors for biohydrogen production.

Microbial Fuel cells: Biochemical Basis; Fuel Cell Design: Anode & Cathode Compartment, Microbial Cultures, Redox Mediators, Exchange Membrane, Power Density; MFC Performance Methods: Substrate & Biomass Measurements, Basic Power Calculations, MFC Performance: Power Density, Single vs Two-Chamber Designs, Wastewater Treatment Effectiveness; Advances in MFC.

UNIT-III

Recovery of Biological Conversion Products **10 Hours**

Bio gasification of municipal solid waste: Anaerobic processing; Types of digesters, Biogas plant in India.

Thermochemical processing: Planning an incineration facility, Incineration technologies: Mass burning system; Refuse derived fuel (RDF) system; modular incineration; Fluidized bed incineration; energy recovery; Fuel production through biomass incineration, Pyrolysis and gasification, hydrothermal processing.

Course Outcomes: At the end of the course student will be able to

1.	Mark the significance of biofuels and raw materials and Identify suitable feedstock for production of biofuels.
2.	Illustrate the production of liquid biofuels from various feed stocks.
3.	Demonstrate production of biohydrogen using microbial sources.
4.	Extend the concepts of microbial fuel cells towards development of specific application.
5.	Understand and apply the concepts of biochemical processing to harvest energy from waste products/streams.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
BT1501-1.1	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.2	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.3	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.4	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.5	-	2	-	-	-	-	-	-	1	-	-	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Drapcho, C. M., Nhuan, N. P.and Walker, T. H. , "Biofuels Engineering Process Technology", Mc Graw Hill Publishers, New York, 2008.
2.	Jonathan R.M, Biofuels, "Methods and Protocols (Methods in Molecular Biology Series)", Humana Press, New York, 2009.
3.	Olsson L. (Ed.), "Biofuels (Advances in Biochemical Engineering/Biotechnology Series", Springer-Verlag Publishers, Berlin, 2007.
4.	Glazer, A. and Nikaido, H., "Microbial Biotechnology – Fundamentals of Applied Microbiology", 2 Ed., Cambridge University Press, 2007.
5.	Godfrey Boyle (Ed). "Renewable Energy- Power for sustainable future", 3rd Ed. Oxford. 2012.
6.	Ramachandran, T. V., "Management of municipal solid waste", Environmental Engineering Series. Teri Press, 2016.

SOLID WASTE MANAGEMENT

Course Code:	**BT1502-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Biotechnology

Course Objectives:

1.	To learn types of solid wastes, collection, treatment and disposal methods.
2.	To understand various processing techniques and regulations of treatment and disposal.

UNIT-I

Introduction to Solid Wastes and its Segregation & Transportation	**15 Hours**

Solid waste – Definition, Sources of waste, Classification of Solid waste, Characteristics of Solid Waste (Physical, Chemical, Biological), Solid waste problems – impact on environment and health. Concept of waste reduction, recycling and reuse.

Waste collection and segregation: Solid waste generation, Onsite handling and segregation of wastes at source, Collection and storage of municipal solid wastes, Equipment used and manpower required in collection, Collection systems and routes.

Transportation: Transfer stations: types, location, maintenance, Methods and means of transportation.

UNIT-II

Processing Techniques, Recovery of Resources and Waste Disposal	**15 Hours**

Processing Techniques: Unit operations for separations and processing, mechanical and thermal volume reduction, Incineration of solid wastes – process and types of incinerators (liquid injection, rotary kiln and fluid bed), Biological processing – composting, vermicomposting, biomethanation, fermentation, Drying and dewatering of wastes.

Recovery of Resources: Heat recovery in incineration process, energy recovery and conversion of products from biological processes.

Dumping of solid wastes, Landfills – Types, site selection, preliminary design, operation, case study, Advantages and disadvantages of landfills, Leachate and landfill gases: Collection and treatment, Landfill disposal for hazardous wastes, biomedical waste.

UNIT-III

Solid Waste Management Rules and Planning Issues	**10 Hours**

Legislative trends and impacts: Major legislations, Government agencies. Municipal Solid Waste Management Act (1999), Hazardous Wastes (Handling and Management) Rules, Biomedical Waste (Handling and Management) Rule (1998), e-Waste (Management and Handling) Rule 2011.

Planning and developing a site for solid waste management, Site Remediation: Assessment and Inspection, Remedial techniques, Siting guidelines.

Course Outcomes: At the end of the course student will be able to

1.	Identify the sources, classification and characteristics of solid wastes
2.	Develop insight into the collection, transfer, and transport of solid waste.
3.	Apply waste processing techniques and recovery of resources from the waste.
4.	Select the alternatives of solid waste disposals and its impacts.
5.	Acquire knowledge about solid and hazardous waste management legislative rules.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ **Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
BT1502-1.1	1	-	-	-	-	-	-	-	1	-	-	-
BT1502-1.2	1	1	-	-	-	1	1	-	1	-	-	-
BT1502-1.3	-	2	-	-	-	-	-	-	1	-	-	-
BT1502-1.4	-	2	-	-	-	1	1	-	1	-	-	-
BT1502-1.5	1	-	-	-	-	-	-	-	1	-	-	1

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Tchobanaglous, G., Theisen, H. and Vigil, S. A. "Integrated Solid Waste Management", McGraw – Hill. 1993.
2.	Tchobanoglous, G., Thiesen, H., Ellasen, "Solid Waste Engineering Principles and Management", McGraw – Hill, 1997.
3.	Landrefh, R. E. and Sundaresan, B. B. "Solid Waste Management in Developing Countries", Indian National Scientific Documentation Centre. New Delhi, 2000.

FUNDAMENTALS OF AI AND ML

Course Code:	**CS2501-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50**
Prerequisite	**CS1651-1**		

Teaching Department: Computer Science & Engineering

Course Objectives:

1.	Analyze the most fundamental knowledge to the students so that they can understand what the AI is.
2.	Gain a historical perspective of AI and its foundations
3.	Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4.	Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool.
5.	Explore the current scope, potential, limitations, and implications of intelligent systems.

UNIT-I

Introduction — **15 Hours**

What is AI? Foundation of AI, Early History of AI, The Middle Ages and Dark Ages of AI, Renaissance, Future of AI.

Intelligence of AI

AI An Impossible Task, Animal Intelligence, Brain Size And Performance, Sensing And Movement, Subjective Intelligence, Iq Tests. Comparative Intelligence,

Chapter No 1: Introduction and Intelligence (Page No 11-37)

UNIT-II

Classical Artificial Intelligence — **15 Hours**

Introduction, Expert Systems, Conflict Resolution, Multiple Rules, Forward Chaining, Backward Chaining, Problems With Expert Systems, Fuzzy Logic, Fuzzification, Fuzzy Rules, Defuzzification, Fuzzy Expert System, Problem Solving. Chapter No 2: Classical AI (Page No 38-45)

UNIT-III

Foundations of Machine Learning — **10 Hours**

What is machine learning? Applications of Machine learning, Understand Data, Types of machine learning: Supervised, Unsupervised, Reinforcement Learning, Theory of learning: feasibility of learning, error and noise, training versus testing, theory of generalization, bias and variance, learning curve,.

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamental understanding of the history of artificial intelligence (AI) and its foundation

2.	Interpret the basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
3.	Describe the awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models
4.	Identify and explain the proficiency developing applications in an 'AI language', expert system shell, or data mining tool.
5.	Explain the fundamental concept and importance of machine learning.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CS2501-1.1	3	3	-	-	-	-	-	-	-	-	-	-
CS2501-1.2	3	3	-	-	-	-	-	-	-	-	-	-
CS2501-1.3	3	3	-	-	-	-	-	-	-	-	-	-
CS2501-1.4	3	3	2	-	-	-	-	-	-	-	-	-
CS2501-1.5	3	3	2	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kevin Warwick, "Artificial Intelligence the basics", Typeset in Bembo by Wearset Ltd, Boldon, Tyne and Wear, Library of Congress Cataloging in Publication Data Warwick, K. ISBN: 978-0-415-56482-3 (hbk).

REFERENCE BOOKS:

1.	Stuart Russel and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson 3rd Edition , 2016.
2.	Dan W Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson, 1st edition 2015.
3.	Elaine Rich, "Artificial Intelligence", Mc Graw Hill 3rd Edition, 2017.

E Books / MOOCs/ NPTEL

1.	Practical Artificial Intelligence Programming With Java, Third Edition ,Mark Watson
2.	Artificial Intelligence -http://www.nptelvideos.in/2012/11/artificial-intelligence.html
3.	http://nptel.ac.in/courses/106105077/
4.	https://www.udemy.com/artificial-intelligence
5.	https://www.edx.org/course/artificial-intelligence-ai-columbiax-csmm-101x-4

INTRODUCTION TO DATA STRUCTURES

Course Code:	**CS2502-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L:T:P:S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50**
Prerequisite	**CS1001-1**		

Teaching Department: Computer Science & Engineering

Course Objectives:

1.	Outline the concepts of data structures, types, operations, structures, pointers
2.	Implement linear data structures stacks, queues and usage of stacks in various applications.
3.	Implement the operations of singly linked lists
4.	Identify and differentiate different types of binary trees and binary search trees data structures
5.	Illustrate and classify threaded binary trees.

UNIT-I

Introduction — **15 Hours**

Data Structure, Classification (Primitive and non-primitive), data structure operations, Arrays, Pointers and structures, Dynamic Memory Allocation Functions,

Linear Data Structures – Stacks

Introduction and Definition, Representation of stack: Array and structure representation of stacks, Operations on stacks,

Applications of Stack

Conversion of Expressions, Evaluation of expressions, Recursion: Implementation, Simulating Recursion, examples on Recursion.

UNIT-II

Linear Data Structures – Queues — **15 Hours**

Introduction and Definition Representation of Queue: Array and Structure, representation of Queue, Various queue structures: ordinary queue, circular Queue

Linear Data Structures - Linked Lists

Definition and concepts singly linked List: Representation of link list in memory, Operations on singly Linked List, Circular Linked List, Doubly Linked List: Representation and Operations, Circular doubly Link list: Representation and Operations.

UNIT-III

Nonlinear Data Structures- Tree Data Structures — **10 Hours**

Basic Terminologies, Binary Trees: Properties, Representation of Binary Tree: Linear representation, Linked representation, Operations on Binary Tree: Insertion, traversals. Introduction to Binary Search Tree

Course Outcomes: At the end of the course student will be able to

1.	Acquire the fundamental knowledge of various types of data structures and pointers.
2.	Apply the fundamental programming knowledge of data structures to design stack and use them for solving problems.
3.	Apply the fundamental programming knowledge of data structures to design queues and use them for solving problems.
4.	Design various functions for implementation of linked list.
5.	Implement and apply the concept of binary trees and binary search tree data structure.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CS2502-1.1	-	-	-	-	-	-	-	-	-	-	-	-
CS2502-1.2	3	1	2	-	-	-	-	1	-	-	-	1
CS2502-1.3	3	2	2	-	-	-	-	1	-	-	-	1
CS2502-1.4	3	2	-	-	-	-	-	1	-	-	-	1
CS2502-1.5	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Aaron M. Tenenbaum, Yedidyah Langsam& Moshe J. Augenstein, "Data Structures using C", Pearson Education/PHI, 2009.
2.	Ellis Horowitz and Sartaj Sahni, "Fundamentals of Data Structures in C", 2nd edition, Universities Press, 2014.

REFERENCE BOOKS:

1.	Seymour Lipschutz, "Data Structures, Schaum's Outlines", Revised 1st edition, McGraw Hill, 2014.

E Books / MOOCs/ NPTEL

1.	Data Structures Using C, ISRD Group, Tata McGraw Hill, 2006.
2.	Data Structures Using C, Reema Thareja, 2nd edition, Oxford University Press, 2014
3.	Introduction to Data Structures by edx , URL: https://www.edx.org/course/
4.	Data structures by Berkley, URL: https://people.eecs.berkeley
5.	Advance Data Structures by MIT OCW , URL: https://www.mooclab.club/
6.	Data Structure by Harvard Extension School, URL: http://www.extension.harvard.

DISASTER MANAGEMENT

Course Code:	**CV2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Understand difference between Disaster, Hazard, Vulnerability, and Risk.
2.	Know the Types, Trends, Causes, Consequences and Control of Disasters
3.	Apprehend Disaster Management Cycle and Framework.
4.	Know the Disaster Management in India
5.	Appreciate Applications of Science and Technology for Disaster Management.

UNIT-I

Understanding Disasters — **04 Hours**

Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.

Types, Trends, Causes, Consequences and Control of Disasters — **10 Hours**

Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters

UNIT-II

Disaster Management Cycle and Framework — **10 Hours**

Disaster Management Cycle and Framework: Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action.

Disaster Management in India — **06 Hours**

Disaster Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt, Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies.

UNIT-III

Applications of Science and Technology for Disaster Management	**06 Hours**

Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India

Case Studies	**04 Hours**

Study of Recent Disasters (at local, state and national level), Preparation of Disaster Risk Management Plan of an Area or Sector, Role of Engineers in Disaster Management

Course Outcomes: At the end of the course student will be able to

1.	Explain Concepts, Types, Trends, Causes of Disasters
2.	Describe Consequences and Control of Disasters
3.	Explain Disaster Management Cycle and Framework
4.	Explain the lesson learnt from the disasters in India and discuss the financial mechanism, roles and responsibilities of Non-Government and Inter-Governmental Agencies for Disaster management
5.	Describe the Applications of Science and Technology recent disasters, role of engineers for Disaster Management and prepare a report of Disaster Risk Management Plan.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12
↓ Course Outcomes												
CV2501-1.1	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.2	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.3	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.4	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.5	-	-	-	-	-	3	2	-	-	-	1	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Noble, L. , "Introduction to environmental impact assessment. A Guide to Principles and Practice", 2nd edition, Oxford University Press, Don Mills, Ontario, 2010.
2.	Larry W. Canter, "Environmental Impact Assessment", McGraw Hill Inc. Singapore, 1996.

REFERENCE BOOKS:

1.	Morris and Therivel, "Methods of Environmental Impact Assessment", 3rd edition. New York, NY: Routledge, 2009.
2.	Hanna, K. S., "Environmental impact assessment", Practice and Participation. 2nd edition. Oxford, University Press, Don Mills, Ontario, 2009.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/120108004/
2.	http://nptel.ac.in/courses/120108004/module3/lecture3.pdf

ENVIRONMENTAL HYGIENE, SANITATION AND WASTE MANAGEMENT

Course Code:	**CV2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Creation of awareness among student's health issues and Swachh Bharath mission and the consequent responsibilities.
2.	To understand the culture cleanliness, engineering applications in creation of ODF (Open defecation free) concept, Importance of legal & cultural issues related to Environmental Hygiene.
3.	To know the importance of sanitation, gender sensitive sanitation issues & use of engineering technology in construction of toilets.
4.	To know the importance of waste management system, wastewater audit and waste water treatment process.
5.	To study the role of student in Swachh Bharata Abhiyan, solid and waste water treatment process.

UNIT-I

Prospective: Environmental Hygiene (EH), Sanitation, Solid Waste and Wastewater	**06 Hours**
Introduction- Swachh Bharath Mission (SBM)-Mission Objectives-Duration- Components Environmental Hygiene-Benefits-Sanitation-Waste Management. Work opportunities in Environmental Hygiene, Sanitation and Waste Management. Participatory Learning for Environmental Hygiene, Sanitation and Waste Management.	
Sociology of environmental hygiene management, solid waste and waste water and impacts	**08 Hours**
Open Defecation-Habits & attitude towards waste-Goals of SBA. Community Consciousness and Engagement on Sanitation Aspects, Roles & Responsibilities, Job Charts, Frequency, Schedules and Timelines in Swachhata Management, Culture of Cleanliness (Swachh Bharat Abhiyan), Behaviour Change Communication, Role of Habits and Attitudes in Environmental Hygiene Management, Waste and Wastewater Disposal; Change Management.	

UNIT-II

Infrastructure for Sanitation	**08 Hours**
Containment-Preparation of toilets –Toilet Types Evaluation of Construction and Maintenance of Community, Public, Institutional and Individual Sanitation Infrastructure Toilets-Proportion and Number of toilets, Gender Sensitive Sanitation Facilities, Ramps for Differently Abled, Types – Indian and Western. Faecal Sludge treatment - Single / Twin pit, Eco San, Septic Tank and Formal Sewerage.	

Solid Waste Management	**08 Hours**
Swachh Survekshan- Solid Waste management- Steps- Waste Audit-Classification Methods of Solid Waste Disposal and Management-Composting-Different types of composting- Waste Minimization-Waste Management.	

UNIT-III

Waste & Wastewater Audit	**06 Hours**
Waste Audit -Environmental Impact Assessment, Waste Characterization, Quantity Determination, Primary Collection Methods, Secondary Transportation. **Wastewater Audit**-Water Budget, Types of Wastewater, Survey of Distribution Network and Feasibility of Various Wastewater Treatment Methods.	
Swachh Bharath Mission and Inclusivity	**04 Hours**
Swacch Bharath Mission in rural & Urban Context-Gender Issues in sanitation. Role of women in Sanitation.	

Course Outcomes: At the end of the course student will be able to

1.	Creation of awareness among student's health issues and Swachh Bharath mission and the consequent responsibilities.
2.	To understand the culture cleanliness, engineering applications in creation of ODF (Open defecation free) concept, Importance of legal & cultural issues related to Environmental Hygiene.
3.	To know the importance of sanitation, gender sensitive sanitation issues & use of engineering technology in construction of toilets.
4.	To know the importance of waste management system, wastewater audit and waste water treatment process.
5.	To study the role of student in Swachh Bharata Abhiyan, solid and waste water treatment process.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CV2502-1.1	1	1	-	-	-	2	3	2	-	-	-	-
CV2502-1.2	1	1	-	-	-	2	3	2	-	-	-	-
CV2502-1.3	1	1	-	-	-	2	3	2	-	-	-	-
CV2502-1.4	1	1	-	-	-	2	3	2	-	3	-	-
CV2502-1.5	1	1	-	3	-	2	3	2	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Joanne E. Drinan and Frank Spellman, "Water and Wastewater Treatment: A Guide for the Non-engineering Professional".

2.	M. S. Bhatt and Asheref Illiyan, "Solid Waste Management: An Indian Perspective".
3.	Jagbir Singh, "Solid Waste Management: Present and Future Challenges".
4.	M. S. Bhatt, "Solid Waste Management: An Indian Perspective".
5.	T. V. Ramachandra, "Management of Municipal Solid Waste".
6.	Syed R. Qasim, "Wastewater Treatment Plants: Planning, Design and Operation".
REFERENCE BOOKS:	
1.	Swachhbharatmission.gov.in/
2.	https://www.india.gov.in//swachh-bharat-mission-gramin-portal
3.	https://www.swachhsurvekshan2018.org/
4.	https://zerowasteeurope,eu/
5.	www.zerowasteindia.in/
E Books / MOOCs/ NPTEL	
1.	http://www.un.org/waterforlifedecade/pdf/award_south_africa_eng_for_web.pdf
2.	http://www.sulabhinternational.org
3.	http://swachhbharatmission.gov.in/sbmcms/writereaddata/images/pdf/Guidelines /Complete-set-guidelines.pdf

ENVIRONMENTAL IMPACT ASSESSMENT

Course Code:	**CV2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Identify the need to assess and evaluate the impact of projects on environment.
2.	Explain major principles of environmental impact assessment.
3.	Understand the different steps within environmental impact assessment.
4.	Appreciate the importance of EIA for sustainable development and a healthy environment.

UNIT-I

Evolution of EIA	**16 Hours**

Concepts of EIA, EIA methodologies (Adhoc, Network Analysis, Checklists, Map overlays, Matrix method), Screening and scoping, Rapid EIA and Comprehensive EIA, General Framework for Environmental Impact Assessment, EIA Specialized areas like environmental health impact assessment, Environmental risk analysis.

UNIT-II

14 Hours

Baseline data study, Prediction, and assessment of impacts on physical, biological, and socio-economic environment, Legislative and environmental clearance procedures in India, Public participation, Resettlement, and rehabilitation.

UNIT-III

10 Hours

Fault free analysis, Consequence Analysis, Introduction to Environmental Management Systems, Environmental management plan-Post project monitoring Environmental Audit: Cost Benefit Analysis, Life cycle Assessment. Case studies on project, regional and sectoral EIA.

Course Outcomes: At the end of the course student will be able to

1.	Understand phenomena of impacts and know the impact quantification of various projects in the environment.
2.	Liaise with and list the importance of stakeholders in the EIA process.
3.	Know the role of public in EIA studies.
4.	Overview and assess risks posing threats to the environment.
5.	Assess different case studies/examples of EIA in practice.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
CV2503-1.1	1	1	-	-	-	2	3	2	-	-	-	-
CV2503-1.2	1	1	-	-	-	2	3	2	-	-	-	-
CV2503-1.3	1	1	-	-	-	2	3	2	-	-	-	-
CV2503-1.4	1	1	-	-	-	2	3	2	-	3	-	-
CV2503-1.5	1	1	-	3	-	2	3	2	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Noble, L., "Introduction to environmental impact assessment. A Guide to Principles and Practice", 2nd edition, Oxford University Press, Don Mills, Ontario, 2010.
2. Larry W. Canter, "Environmental Impact Assessment", McGraw Hill Inc. Singapore, 1996.

REFERENCE BOOKS:

1. Morris and Therivel, "Methods of Environmental Impact Assessment", 3rd edition. New York, NY: Routledge, 2009.
2. Hanna, K. S., "Environmental impact assessment. Practice and Participation". 2nd edition. Oxford, University Press, Don Mills, Ontario, 2009.

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/120108004/
2. http://nptel.ac.in/courses/120108004/module3/lecture3.pdf

INTRODUCTION TO GEOINFORMATICS

Course Code:	**CV2504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T: P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1001-1, CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Explain the basic principles of Geoinformatics comprising Remote sensing, Photogrammetry, GPS, GNSS & GIS.
2.	Explain the stages and techniques of photogrammetry, aerial photo interpretation, visual & digital image processing, enhancement and interpretation.
3.	Explain and Appraise GIS - its components, data structures, process and operation, Map and its projections, components, preparation and overlays
4.	Explain the GIS functionality and Appraise the significance of GEOINFORMATICS (Photogrammetry, RS, GPS, GNSS & GIS) in real world applications.

UNIT-I

16 Hours

Remote sensing and its Principles: Physics of remote sensing, EM spectrum, Blackbody concept, atmospheric windows, spectral response of common earth features.
Platforms & Sensors: Ground based, Air borne and Space borne platforms, Active and Passive Sensors, Photographic sensors, scanners, radiometers, RADAR and thermal infrared, hyper spectral remote sensing, Indian satellites and sensors: capabilities, data products
Photogrammetry: Basic principles of Aerial photography and Photogrammetry, Flight procedures, Aerial Photo Interpretation and Analysis techniques.
Satellite Image Interpretation and Analysis techniques: Visual & Digital Image interpretation, Interpretation elements, False Colour Composites (FCC).

UNIT-II

15 Hours

Digital Image Processing and Analysis: Digital image formats, pre-processing and processing (DIP), image restoration/enhancement procedures, information extraction, pattern recognition concepts, post processing procedures.
Geographic Information System -concept and spatial models: Fundamentals of GIS, spatial and non-spatial data, vector and raster GIS, GIS Hardware and software, georeferencing, digitization, thematic maps, Overlay Analysis, Operation of GIS, Co-ordinate systems and map projections, Map scale, data display and cartography.

UNIT-III

09 Hours

Geoinformatics and Virtual GIS: Modern Surveying and Geoinformatics, GPS & GNSS, GIS Functionality: Introduction, data acquisition, preliminary data processing, data storage and retrieval, spatial search and analysis, graphics and interaction, Virtual GIS and Real world applications.

Course Outcomes: At the end of the course student will be able to

1.	Define and explain the principles of Remote Sensing and list various types of platforms, sensors & resolutions in RS with a special reference to Indian satellites and data products.
2.	Explain Photogrammetry, its basic principles, elements of photo interpretation, Visual & Digital Image interpretation techniques
3.	Explain different stages involved in Digital Image Processing, various image enhancement techniques, list and classify the digital image formats and the extracted information for various purposes.
4.	Explain and Appraise GIS - its components, data structures, process and operation, Map and its projections, components, preparation and Overlays.
5.	Explain the GIS functionality and appraise the significance of GEOINFORMATICS (Photogrammetry, RS, GPS, GNSS & GIS) and Virtual GIS in real world applications.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CV2504-1.1	2	2	-	-	-	2	-	-	-	-	-	-
CV2504-1.2	2	2	-	-	-	2	1	-	-	-	-	-
CV2504-1.3	2	2	-	-	-	2	1	-	-	-	-	-
CV2504-1.4	2	2	-	-	-	2	1	-	-	-	-	-
CV2504-1.5	2	2	-	-	-	2	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Anji Reddy, M, "Text Book of Remote Sensing and Geographical Information Systems", Fourth Edition, BS Publication, Hyderabad, 2012.
2. Bhatta, Basudeva, "Remote Sensing and GIS", 2nd edition, Oxford University Press, N. Delhi, 2011.
3. Lillesand, T.M., Kiefer, R.W and Chipman, J. W., "Remote sensing and Image Interpretations", 7th edition, John Wiley and sons, New Delhi, 2015.

REFERENCE BOOKS:

1. Anji Reddy, M. and Hari Shankar, Y., "Digital Image Processing", BS Pub., Hyd, 2006.
2. Bernhardsen, Tor, "Geographic Information Systems", 3rd Ed., Wiley India, Delhi, 2002.
3. Canada Centre for Remote Sensing, Fundamentals of Remote sensing-Tutorial, 2011.
4. Chang, Kang-tsung, "Introduction to Geographic Information Systems", 4th Ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

5.	Korte, George B., "The GIS Book", Onword Press, Thomson Learning Inc., USA, 2001.
6.	Kumar, S., "Basics of Remote sensing and GIS", Laxmi Publications (P) Ltd., Delhi, 2008.
7.	Longler, Paul A., Goodchild, Michael F., Maguire, David J., Rhind. David W., "Geographic Information Systems and Science", John Wiley & Sons Ltd., ESRI Press, 2004.
8.	Sabins, F. L., "Remote Sensing: Principles and Interpretation" 3rd edn. WH Freeman and Company, New York, 1997.
E Books / MOOCs/ NPTEL	
1.	https://www.youtube.com/user/edusat2004
2.	https://eclass.iirs.gov.in/login

CORROSION SCIENCE

Course Code:	**CY2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CY1001-1**		

Teaching Department: Chemistry

Course Objectives:

1.	To provide fundamental understanding aspects of electrochemistry and material science related to corrosion. To understand the types of corrosion attacking on the metal and its preventions.
2.	To impart knowledge on corrosion science and its applications to the engineering materials.
3.	To identify practice for the prevention and remediation of the corrosion. To provide methodologies for measuring the corrosion performance of materials.

UNIT-I

Fundamentals of Corrosion	**09 Hours**
Definition, cost of corrosion, Corrosion Damage and consequences, Classification of corrosion, Electrochemical Aspects of corrosion, Electrochemical reactions, Different Environmental aspects, polarization and passivity, Corrosion Rate Expression, Determination. Standard electrode potential, EMF and Galvanic series, Potential-pH (Roubaix Diagram).	
Forms of Corrosion	**08 Hours**
Galvanic corrosion, Crevices corrosion, Filiform corrosion, Pitting corrosion, Uniform corrosion and Atmospheric corrosion, Inter granular corrosion, Selective leaching, Erosion corrosion, Cavitation damage, Stress corrosion , Impingement attack, Inlet tube corrosion, Corrosion fatigue, Hydrogen blistering, Hydrogen embrittlement.	

UNIT-II

Corrosion at Elevated Temperature	**08 Hours**
High temperature materials, Metal oxides, Pilling bed worth rule, oxide defect structure, Hot corrosion, Corrosion of mineral acids-corrosion of steel, stainless steel, Cu and Al.	
Corrosion Testing	**07 Hours**
Weight loss method, Tafel extrapolation test, linear polarization test and AC impedance method.	

UNIT-III

Corrosion Prevention Methods	**08 Hours**
Materials Selections, Design, Change of the environments: Atmospheric corrosion, Control of atmospheric corrosion, Changing medium, Inhibitors, Cathodic and Anodic protection, Protective coatings.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamentals of difference in electrode potential across an interface in particular a metal/ electrolyte and the relationship between rates of electrochemical reactions and the potential drop across interfaces.
2.	Analyze the causes and mechanisms of various types of corrosion including uniform, galvanic, crevice, pitting, inter granular and various modes of environmentally cracking. Acquire knowledge of influence of a materials composition, the effect of an electrolytes composition on the corrosion of metals and microstructure on its corrosion performance.
3.	Identify the materials that will exhibit adequate corrosion resistance in a particular environment and remedial action that will reduce corrosion to a acceptable level. Explain the concepts of different measuring techniques of corrosion.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CY2501-1.1	3	3	3	-	-	1	1	-	-	-	-	-
CY2501-1.2	3	3	3	-	-	1	1	-	-	-	-	-
CY2501-1.3	3	3	3	-	-	1	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1	Mars G Fontana, "Corrosion Engineering", 3rd Edition, Tata Mcgraw-Hill Edition.

REFERENCE BOOKS:

1	Chamberlian and K. Trethway, "Corrosion", Longman scientific and technical, John Wiley and Sons.

NATURAL PRODUCTS CHEMISTRY

Course Code:	**CY2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CY1001-1**		

Teaching Department: Chemistry

Course Objectives:

1.	Identify the structure of terpenoids and their biosynthesis. Elucidate the structure of β-carotene, haemoglobin and chlorophyll.
2.	Understand the chemistry underlying steroids and sex hormones. Get introduced to the different types of prostaglandins as well as theory and chemistry behind natural dyes.
3.	Gain knowledge on general methods of structural determination of some of the important alkaloids.

UNIT-I

Terpenoids & Carotenoids	**08 Hours**
Introduction and classification, isoprene rules, general methods of determination of structure of terpenoids. Structure elucidation of the following terpenoids-geraniol, α-pinine, camphene and farnesol. Biosynthesis of terpenoids. Introduction and classification of carotenes. Structural elucidation of β-carotene.	
Porphyrins	**07 Hours**
Introduction to porphyrins, structure and degradation products of haemoglobin and chlorophyll.	

UNIT-II

Steroids	**08 Hours**
Introduction, Dile's hydrogenation. Chemistry of cholesterol, Blanc's rule, Barbier-Wielman degradation, Oppenuer oxidation. Constitution of bile acids. Sex hormones: Chemistry of oestrone, progesterone, androsterone and testosterone.	
Prostaglandins & Natural Dyes	**08 Hours**
Introduction, nomenclature, classification, and biological role of prostagladins. Structure elucidation of PGE_1, Biosynthesis of PGE_2 and $PGF_{2\alpha}$. Introduction, Witt's theory of colour, methods of dyeing, chemical constitution of alizarin.	

UNIT-III

Alkaloids	**09 Hours**
Definition, Classification and isolation of alkaloids. General methods of structural determination of alkaloids. Detailed study of structure elucidation of the following alkaloids- papaverine, cinchonine and nicotine.	

Course Outcomes: At the end of the course student will be able to

1	Elucidate the structure of terpenoids like geraniol, a-pinine, camphene and farnesol. Explain the structural chemistry of carotenoids and porphyrins.

2	State the basic reactions governing steroids and sex hormones. Explain the biological role and structure of prostaglandins and state the methods employed for dyeing.
3	Apply the general methods of structural determination to elucidate the structure of alkaloids like papaverine, cinchonine and nicotine.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CY2502-1.1	3	3	-	-	-	1	1	-	-	-	-	-
CY2502-1.2	3	3	-	-	-	1	1	-	-	-	-	-
CY2502-1.3	3	3	-	-	-	1	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	**22.** Agarwal, "Organic Chemistry of Natural Products", Vol.-I & Vol.-II, O.P. Goel Publishing House, 2014.

REFERENCE BOOKS:

1.	K. Nakanishi, T. Goso, S. Ito, S. Natori and S. Nozoe, "Natural Products Chemistry", Vol. I & II, Academic Press, Ny, 1974.
2.	Gurudeep R. Chatwal, "Organic Chemistry of Natural Products", Vol. I & II, Himalaya Publishing House, 2013.
3.	G.A. Swal, "An Introduction to Alkaloids", Backwell Scientific Publications, 1967.
4.	Hand book of naturally occurring Compounds, Vol. II, terpenes, T.K. Davon, A.I. Scott, Academic Press, Ny, 1974.

ARTIFICIAL NEURAL NETWORK SYSTEMS

Course Code:	**EC1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To learn basic building blocks of ANNs and its terminology
2.	To understand the working of McCulloch-Pitts Neuron and different types of learning rules
3.	To understand decision regions, discriminant functions and training concept
4.	To understand the working of perceptron as classifier
5.	To understand the mathematics behind different types of single layer feedback networks

UNIT-I

Introduction to Artificial Neural networks	**16 Hours**

Introduction, Basic building blocks: network architecture, setting the weights, activation functions, ANN terminologies: weights, activation functions, bias, threshold, McCulloch-Pitts Neuron Model, Learning Rules

UNIT-II

Single Layer Perceptron Classifiers	**15 Hours**

Classification Model, Features, and Decision Regions, Discriminant Functions, Linear Machine and Minimum Distance Classification, Nonparametric Training Concept, Training and Classification Using the Discrete Perceptron: Algorithm and Example, Single-Layer Continuous Perceptron Networks for Linearly Separable Classifications, Multicategory Single-Layer Perceptron Networks

UNIT-III

Single-Layer Feedback Networks	**09 Hours**

Basic Concepts of Dynamical Systems, Mathematical Foundations of Discrete-Time Hopfield Networks, Mathematical Foundations of Gradient-Type Hopfield Networks. Transient Response of Continuous-Time Networks, Relaxation Modeling in Single-Layer Feedback Networks

Course Outcomes: At the end of the course student will be able to

1.	Describe the building blocks of artificial neural and terminologies
2.	Describe the working of neural network and learning rules
3.	Describe training of Single layer perceptron and classification using it.
4.	Explain use of Single layer perceptron for linearly separable and multicategory problems
5.	Explain the mathematics behind different single-layer feedback networks

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC1501-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.2	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.3	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.4	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.5	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks Using MATLAB 6.0", Tata McGraw-Hill Education, 2006

2. Jacek M. Zurada "Introduction to Artificial Neural Systems", 1st Edition, St. Paul West Publishers-USA, 1992.

3. Michael A Neilsen, "Neural Networks and Deep Learning", Determination Press, 2015

INTRODUCTION TO MATLAB PROGRAMMING: A HANDS-ON APPROACH

Course Code:	**EC1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**2:0:2:0**	**Credits**	**03**
Total Teaching Hours	**27+0+26+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electronics & Communication Engineering
Offered to Civil & BT

Course Objectives:

1.	To demonstrate basic understanding of MATLAB programming
2.	To use and write functions
3.	To use MATLAB programming for image processing

Unit-I	**27 Hours**

Introduction to MATLAB: Starting MATLAB and familiarization with its user interface, syntax and semantics, ways in which MATLAB provides help, create plots in MATLAB.
Matrices and Operators: defining matrices, manipulation of matrices, extract parts of them and combine them to form new matrices, use of operators to add, subtract, multiply, and divide matrices, and we will learn that there are several different types of multiplication and division.
Functions: creating reusable functions, how the environment inside a function is separated from the outside via a well-defined interface through which it communicates with that outside world, define a function to allow input to it when it initiates its execution.
Programmer's Toolbox: polymorphism and how MATLAB exploits it to change a function's behavior on the basis of the number and type of its inputs, random number generator, how to get input from the keyboard, how to print to the Command Window, and how to plot graphs in a Figure window, how to find programming errors with the help of the debugger, how to print to the Command Window, and how to plot graphs in a Figure window, how to find programming errors with the help of the debugger.
Selection Statement and Loops: how to use the if-statement, how to use relational operators and logical operators, how to write polymorphic functions and how to make functions resistant to error, the for-loop and the while-loop, how the break-statement works, nested loops, logical indexing and implicit loops.
Data Types: character arrays and how the characters in them are encoded as numbers, string and datetime datatype, how to produce heterogeneous collections of data via structs and cells.
File Input/Output: reading and writing files, how to create, read from, and write into MAT-files, Excel files, text files, and binary files, how to navigate among folders with MATLAB commands.
Image Processing using MATLAB: pre-processing – conversion of color image to gray scale image, decomposition of color images to single color component image, histogram of image, thresholding

List of Experiments	
1.	Starting MATLAB and familiarization with its user interface, syntax and semantics, ways in which MATLAB provides help, create plots in MATLAB.
2.	Defining matrices, manipulation of matrices, extract parts of them and combine them to form new matrices, use of operators to add, subtract, multiply, and divide matrices, and we will learn that there are several different types of multiplication and division.
3.	creating reusable functions, how the environment inside a function is separated from the outside via a well-defined interface through which it communicates with that outside world, define a function to allow input to it when it initiates its execution.
4.	Polymorphism and how MATLAB exploits it to change a function's behavior on the basis of the number and type of its inputs, random number generator, how to get input from the keyboard, how to print to the Command Window
5.	How to plot graphs in a Figure window, how to find programming errors with the help of the debugger, how to print to the Command Window, and how to plot graphs in a Figure window, how to find programming errors with the help of the debugger.
6.	How to use the if-statement, how to use relational operators and logical operators, how to write polymorphic functions and how to make functions resistant to error.
7.	The for-loop and the while-loop, how the break-statement works, nested loops, logical indexing and implicit loops.
8.	Character arrays and how the characters in them are encoded as numbers, string and datetime datatype, how to produce heterogeneous collections of data via structs and cells.
9.	Reading and writing files, how to create, read from, and write into MAT-files, Excel files, text files, and binary files, how to navigate among folders with MATLAB commands.
10.	Reading an image, saving, basic manipulation of images, arithmetic operations
11.	Pre-processing – conversion of color image to gray scale image, decomposition of color images to single color component image.
12.	Histogram processing.
13.	Thresholding operation.

Course Outcomes: At the end of the course student will be able to

1.	Use matrices and operators in MATLAB programming
2.	Use and write functions; use MATLAB toolbox
3.	Use toolbox and selection statement in MATLAB programming
4.	Write MATLAB programs using loops and summarize data types
5.	Summarize file input/output methods using MATLAB commands and apply pre-processing and thresholding operations on images

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
EC1502-1.1	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.2	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.3	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.4	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.5	1	-	-	-	3	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Stormy Attaway, "Matlab: A Practical Introduction to Programming and Problem Solving", Second Edition, Butterworth-Heinemann, 2011
2.	Fitzpatrick and Ledeczi, "Computer Programming with MATLAB", eBook, 2013
3.	Rafael C. Gonzalez, Richard E. Woods and Steven L. Eddins, Digital Image Processing using MATLAB, first edition, Dorling Kindersley Pvt Ltd, 2006.

REFERENCE BOOKS:

1.	Duane C. Hanselman, Bruce L. Littlefield, "Mastering MATLAB" , first edition, Pearson, 2011

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/103/106/103106118/
2.	https://www.coursera.org/learn/matlab

ROBOTICS

Course Code:	**EC1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	Understand Anatomy of a robot.
2.	Analyse the robot motion using translation and rotational matrix.
3.	Discuss Robot trajectory planning and robot control.
4.	Categorise the various sensors used in robotics
5.	Understand the robot programming.

UNIT-I

Introduction	**16 Hours**
Definition, anatomy of robot, classification configurations, robot links and joints, robot specifications, resolution accuracy and repeatability, simple numerical problems, robot drive systems, hydraulic, pneumatic and electric drive systems, wrist and its motions, end effectors, types of end effectors, mechanical & Non-mechanical grippers, methods of constraining parts in grippers.	
Motion analysis	
Direct kinematics and inverse kinematics, 3D homogeneous transformations, rotation, translation and displacement matrix, composite rotation matrix, rotation matrix about an arbitrary axis.	

UNIT-II

Control and trajectory planning	**15 Hours**
Trajectory planning, definition, steps in trajectory planning, joint space techniques, use of a p-degree polynomial as interpolation function, cubic polynomial trajectories, linear function with parabolic blends, joint space verses, simple numerical problems on joint space trajectory planning.	
Sensors	
Classification, Types- Contact & Non-Contact sensors.	
Machine Vision	
Machine vision, functions of machine vision system, sensing and digitizing, imaging devices, analog to digital signal conversion, quantization and encoding, simple numerical problems, image storage, image processing and analysis, image data reduction, segmentation, feature extraction, object recognition, robotic machine vision applications, inspection, identification, visual surveying and navigation.	

UNIT-III	
Programming	**09 Hours**
Introduction to robot programming, robot cell layout, work cell control and interlocks, manual programming, lead through and walkthrough programming, off-line programming, robot programming languages, examples	

Course Outcomes: At the end of the course student will be able to

1.	Explain the working principle, various performance parameters of robots and identify the types of robots employed in industry.
2.	Discuss the concept of direct and inverse kinematics. Determine the position and orientation of End-Effector subjected to transformations. Demonstrate the applications of Denavit-Hartenberg (DH) method for different robot configurations.
3.	Determine the technique of trajectory planning, control schemes for robot joints and understand the types of the sensors used in robotics.
4.	Apply engineering knowledge in robot visual surveying and navigation.
5.	Analyze and formulate different types of robot cell layouts and use modern tools to write robot programs for different tasks.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC1503-1.1	3	2	2	1	-	-	-	-	-	-	-	1
EC1503-1.2	3	3	2	2	-	-	-	-	3	3	-	1
EC1503-1.3	3	2	2	2	-	-	-	-	3	3	-	1
EC1503-1.4	3	2	2	1	-	-	-	-	-	-	-	1
EC1503-1.5	3	3	3	2	2	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	R. K. Mittal and I. J. Nagrath, “Robotics and Control”, Tata-McGraw-Hill Publications, 2007.
2.	Mikell P. Groover, Mitchel Weiss, Roger N. Nagel and Nicholas G. Odrey, “Industrial Robotics”, McGraw-Hill Publications, International Edition, 2008

REFERENCE BOOKS:

1.	Fu K. S., Gonzelez R. C., Lee C. S. G., "Robotics: Control, Sensing, Vision, Intelligence," , McGraw Hill Book Co., International edition, 2008.
2.	Yorem Koren, "Robotics for Engineers", McGraw-Hill Publication, International edition, 1987.
3.	Craig, J. J., "Introduction to Robotics: Mechanics and Control", 3rd Edition, Pearson PrenticeHall Publications, 2005.
4.	Schilling R. J., "Fundamentals of Robotics, Analysis and Control", Prentice-Hall Publications, Eastern Economy edition, 2007.
5.	AppuKuttan K. K., "Robotics", I.K. International Publications, First Edition, 2007.
6.	James G. Keramas, "Robot Technology Fundamentals", Cengage Learning, 1999.
7.	Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft Systems", CRC Press, 2012.

8.	Ghosh, "Control in Robotics and Automation", Allied Publishers.
9.	Deb, "Robotics Technology", Wiley India.
E Books / MOOCs/ NPTEL	
1.	https://nptel.ac.in/courses/112105249

CONSUMER ELECTRONICS

Course Code:	**EC2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To provide basic knowledge on sound and transducers
2.	To provide basic knowledge on different display units and camera
3.	To understand the recording process and storage mechanism
4.	To provide basic knowledge on communication and broadcasting
5.	To understand the working of various electronic gadgets

UNIT-I

Sound & Vision — **15 Hours**

Sound: Definition and properties of sound, Transducers: Micro Phone – characteristics and types, and Loud Speakers – characteristics and types, Enclosures and baffles, mono-stereo, audio amplifiers-characteristics, Synthesizers.
Vision: Displays-LED, LCD, PLASMA, Camera: basic principle, CCTV Camera.

UNIT-II

Recording, Playback, Communication & Broadcasting Systems — **15 Hours**

Recording and Playback: Audio recording methods-magnetic recording, optical recording, digital recording, erasing methods, optical discs- recording and playback, Film projector, Theatre Sound, HiFi system.
Communications And Broadcasting: Modulation: AM, FM PCM, Radio transmitters, Radio receivers - Tuned radio frequency receiver and Superheterodyne receiver. Fiber optics, Radio and TV broadcasting. Cellular communication: digital cellular phone, establishing a call.

UNIT-III

Other Electronic Systems — **10 Hours**

Fax machine, Xerox machine, electronic Calculator, Microwave ovens, Washing Machines, A/C and refrigeration, ATM, Auto Electronics, Industrial Electronics and Robotics, Electronics in health / Medicine.

Course Outcomes: At the end of the course student will be able to

1.	Recall basics of sound and transducers.
2.	Understand the working principles of display units and CCTV camera.
3.	Explain basic working of Recording, storage devices
4.	Explain basics of communication and broadcasting
5.	Recall basic working of commonly used electronic gadgets

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
EC2501-1.1	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.2	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.3	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.4	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.5	1	-	-	-	-	1	-	-	-	-	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Anand, “Consumer Electronics”, Khanna publications, 2011.
2. Bali S. P., “Consumer Electronics”, Pearson Education, 2005.

REFERENCE BOOK:

1. Gulati R. R. "Modern Television Engineering", Wiley Eastern.

PCB DESIGN AND FABRICATION

Course Code	**EC2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**1:0:4:0**	**Credits**	**03**
Total Teaching Hours	**15+0+52+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To enable students to gain knowledge of Schematic Design techniques & PCB design techniques
2.	To expose students to complete PCB Design & manufacturing process

Unit-I

Circuit Schematic — **05 Hours**

Introduction to Kicad schematic design tool, features, node connections, labeling, creating new component.

Unit-II

PCB Layout: — **05 Hours**

Introduction to Kicad layout editor, features, layer selections, manual and auto routing in Kicad, verification of footprint, creating footprint for a given component.

Unit-III

PCB Fabrication — **05 Hours**

Generating and verifying the PCB Gerber file, preparing artwork for a single side PCB fabrication, preparing PCB artwork for double side PCB, Etching process, tin plating, legend printing, green masking and through hole plating

List of Experiments

1.	Exploring the Kicad Schematic and layout tool
2.	Developing a schematic circuit for microphone preamplifier
3.	Designing a single side PCB layout for microphone preamplifier
4.	Developing a schematic circuit for a microcontroller development board
5.	Designing a double side PCB layout for a microcontroller development board
6.	Choosing a new sensor/display module and building a schematic circuit for the user level application
7.	Building a layout using single or double side PCB for the sensor/display module
8.	Preparing the film for the bottom copper, solder mask and top silk (legend) to fabricate a single side PCB using chemical process
9.	Preparing the film for the top copper, bottom copper, top solder mask, bottom solder mask and legend to fabricate double side PCB using chemical process
10.	PCB routing, etching, cutting and drilling using CNC machine

Course Outcomes: At the end of the course student will be able to

1.	Draw schematic circuit and create PCB layout for single or multilayer PCB

2.	Fabricate single and double-layer PCB

Course Outcomes Mapping with Program Outcomes

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12
↓ Course Outcomes												
EC2502-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EC2502-1.2	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Peter Dalmaris, "Kicad Like a Pro", Tech Exploration.

REFERENCE BOOKS:

1.	Peter Dalmaris, "Kicad Like a Pro", Tech Exploration.
2.	David L. Jones, "PCB Design Tutorials", Alternate zone, 2004.

E Books / MOOCs/ NPTEL

1.	www.alternatezone.com

SPACE TECHNOLOGY AND APPLICATIONS

Course Code:	**EC2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	Understand the general laws governing satellite orbits and its parameters.
2.	Discuss effect of space environment on satellite signal propagation.
3.	Illustrate various segments employed in satellite and ground station.
4.	Calculate the uplink / downlink subsystem characteristics.
5.	know the effects on the EM waves in propagation through space.
6.	Explain the satellite launch in the space and their applications in remote sensing.
7.	Discuss the different communication systems used for satellite access.
8.	Summarise Advanced space systems for mobile communication, VSAT, GPS.

UNIT-I

Satellite Technology — **15 Hours**

Satellite communications: Introduction, Kepler's laws, definitions, orbital element, apogee and perigee heights, orbit perturbations, inclined orbits.

Space environment: Earth's Atmosphere, Ionosphere and Meteorological effects on space systems, propagation of signal, Transmission losses in space environment.

Satellite Technology: Space segment, Ground segment, Quality and Reliability, Satellite Communication systems.

UNIT-II

Space Applications — **15 Hours**

Launch Vehicles: Working, stages, Fuel, payload protection, Navigation, guidance and control, Reliability, launching into outer space and launch bases. Types of launch vehicles.

Space Applications: Digital DBS TV, DBS-TV System Design, Master Control Station and Uplink Antennas. Introduction, Radio and Satellite Navigation,

Remote Sensing: Introduction to Remote Sensing, Concepts and Applications of satellite Remote sensing.

UNIT-III

Advanced Space Systems — **10 Hours**

Satellite Access: Introduction, Single Access, Pre-assigned FDMA, Demand-Assigned FDMA, Spade system.

Advanced space systems: Satellite mobile services, VSAT, Radarsat, orbital communication**.** Global Positioning Satellite System (GPS).

Course Outcomes: At the end of the course student will be able to

1.	Discuss the fundamental principles of Satellite communication systems.

2.	Understand the Propagation impairments of satellite link.
3.	Explain various segments employed in satellite and ground station.
4.	Discuss the satellite launch mechanism and roll of those satellite in remote sensing.
5.	Understand the different communication systems used for satellite access and list the recent satellites that have been launched for mobile communication, GPS.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC2503-1.1	3	2	2	-	1	-	-	-	-	-	-	-
EC2503-1.2	-	3	-	-	2	1	-	-	-	-	-	-
EC2503-1.3	3	-	-	1	-	1	1	-	-	-	-	-
EC2503-1.4	-	-	-	-	-	1	3	-	-	-	-	-
EC2503-1.5	-	-	-	-	-	3	3	2	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Dennis Roddy, “Satellite Communications”, McGraw Hill ,1996.
2. Timothy Pratt, “Satellite Communications”, Wiley India Ltd , 2006.
3. K Ramamurthy, “Rocket Propulsion”, McMillan Publishers India Ltd, 2010.

REFERENCE BOOKS:

1. George Joseph, “Fundamentals of Remote Sensing”, Universities press, India 2003.
2. B C Pande, “Remote sensing and Applications”, VIVA Books pvt ltd, 2009.
3. Meynart Roland, “Sensors systems and next generation satellites”, SPIE Publication.
4. Thyagarajan , “Space Environment”, ISRO Hand Book Publication.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/101106046

BATTERY MANAGEMENT SYSTEM

Course Code:	**EE2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1	To familiarize various concepts of BMS
2	To understand functional blocks of BMS
3	To study design steps of BMS
4	To introduce hardware implementation of BMS

UNIT-I

Battery System — **08 Hours**

Introduction, Cells, Batteries, and Packs, Resistance, Li-Ion Cells, Formats, Chemistry, Safety, Safe Operating Area, Efficiency, Aging, Modeling, Unequal Voltages in Series Strings, Li-Ion BMSs, BMS Definition, Li-Ion BMS Functions, Custom Versus Off-the-Shelf, Li-Ion Batteries, SOC, DOD, and Capacity, Balance and Balancing, SOH

BMS Options — **07 Hours**

Functionality, CCCV Chargers, Regulators, Meters, Monitors, Balancers, Protectors, Functionality Comparison, Technology, Simple (Analog), Sophisticated (Digital), Technology Comparison, Topology, Centralized, Modular Master-Slave, Distributed, Topology Comparison

UNIT-II

BMS Functions — **07 Hours**

Measurement, Voltage, Temperature, Current, Management, Protection, Thermal Management, Balancing, Redistribution, Distributed Charging, Evaluation, State of Charge and Depth of Discharge, Capacity, Resistance, State of Health (SOH), External Communications, Dedicated Analog Wire, Dedicated Digital Wire, Data Link, Logging and Telemetry, Off-the-Shelf BMSs, Cell Manufacturers' BMSs, Comparison

Custom BMS Design — **08 Hours**

Using BMS ASICs , BMS ASIC Comparison, Analog BMS Design, Analog Regulator, Analog Monitor, Analog Balancer, Analog Protector, Ready-Made, Digital BMS Designs, ATMEL's BMS Processor, Elithion's BMS Chip Set, National Semiconductors' Complete BMS, Peter Perkin's Open Source BMS, Texas Instruments' bq29330/bq20z90, Texas Instruments' bq78PL114/bq76PL102, Custom Digital BMS Design, Voltage and Temperature Measurement, Current Measurement, Evaluation, Communications, Optimization, Switching, Logging, Cell Interface, Non-distributed, Distributed, Distributed Charging

UNIT-III

Deploying a BMS — **10 Hours**

Installing, Battery Pack Design, BMS Connections to Pack, BMS Connections to System, Configuring, Cell Configuration, Pack Configuration, System Configuration, Testing, Troubleshooting, Grounding, Shielding, Filtering, Wire Routing

Course Outcomes: At the end of the course student will be able to

1	Identify process to implement BMS
2	Describe various communication protocol involved in BMS
3	Illustrate functionality of BMS
4	Apply concepts of BMS using application specific IC
5	Analyse the hardware implementation aspects of BMS

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2501-1.1	1	3	-	-	-	-	-	-	-	-	-	-
EE2501-1.2	1	3	-	-	-	-	-	-	-	-	-	-
EE2501-1.3	1	2	3	-	-	-	-	-	-	-	-	-
EE2501-1.4	1	2	2	3	-	-	-	-	-	-	-	-
EE2501-1.5	1	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1	Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs", ARTECH HOUSE 2010.

REFERENCE BOOKS:

1	Rui Xiong, "Battery Management Algorithm for Electric Vehicles", Springer 2019.
2	Nicolae Tudoroiu, "Battery Management Systems of Electric and Hybrid Electric Vehicles", MDPI 2021

BIOMEDICAL INSTRUMENTATION

Course Code:	**EE2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	The course is designed to give the basic concepts of Instrumentation involved in medical field and human physiology.
2.	To introduce an fundamental of transducers as applicable to physiology
3.	To explore the human body parameter measurements setups
4.	To make the students understand the basic concepts of forensic techniques.
5.	To give basic ideas about Electrophysiological measurements, medical imaging

UNIT-I

Physiology and transducers	**08 Hours**

Cell and its structure, Resting and Action Potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardiovascular system, respiratory system, Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers, Temperature measurements, Fiber optic sensors.

Electro – Physiological measurements	**09 Hours**

Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms. Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment.

UNIT-II

Non-electrical parameter measurements	**08 Hours**

Measurement of blood pressure, Cardiac output, Heart rate, Heart sound Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers : pH of blood, measurement of blood pCO_2, pO_2, finger-tip oximeter, ESR, GSR measurements

Medical Imaging	**07 Hours**

Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, fMRI, Ultrasonography, Endoscopy, Thermography, Different types of biotelemetry systems and patient monitoring

UNIT-III

Assisting and therapeutic equipments:	**08 Hours**

Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart Lung machine, Audio meters, Dialyzers, Lithotripsy

Course Outcomes: At the end of the course student will be able to

1	Understand the physiology of biomedical system
2	Measure biomedical and physiological information
3	Discuss the application of Electronics in diagnostics and therapeutic area.
4	Analyze the images and do a prediction using image processing.
5	Understand the different equipment's used for various measurements of physiology

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2502-1.1	3	3	-	2	1	1	-	-	-	-	-	-
EE2502-1.2	2	2	2	2	-	-	-	-	-	-	-	-
EE2502-1.3	3	2	2	1	2	1	-	-	-	-	-	-
EE2502-1.4	2	3	-	-	1	-	-	-	-	-	1	-
EE2502-1.5	3	3	-	-	2	-	-	-	-	-	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, "Bio-Medical Instrumentation and Measurements", II edition, Pearson Education, 2002.
2.	R. S. Khandpur, "Handbook of Bio-Medical instrumentation", Tata McGraw Hill Publishing CoLtd., 2003.
3.	J. Webster, "Medical Instrumentation", John Wiley & Sons, 1995.
4.	L. A. Geddes and L. E. Baker, "Principles of Applied Bio-Medical Instrumentation", John Wiley & Sons, 1975.
5.	David. Cooney and Michel Deckker, "Bio- Medical Engineering Principles", INC.

REFERENCE BOOKS:

1	David Cooney, "Bio-Medical Engineering Principles", 2015, 1st Edition, Marcel Deckker Pub Co., New York.

ELECTRIC VEHICLE TECHNOLOGY

Course Code:	**EE2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1	To Understand the fundamental laws and vehicle mechanics.
2	To Understand working of Electric Vehicles and recent trends.
3	Ability to analyze different power converter topology used for electric vehicle application
4	Ability to develop the electric propulsion unit and its control for application of electric vehicles

UNIT-I

Vehicle Mechanics	**07 Hours**

Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradability, Velocity and Acceleration, Constant FTR, Level Road, Velocity Profile, Distance Traversed, Tractive Power, Energy Required, Nonconstant FTR, General Acceleration, Propulsion System Design..

Electric and Hybrid Electric Vehicles	**07 Hours**

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive train).

UNIT-II

Energy storage for EV and HEV	**08 Hours**

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.

Electric Propulsion	**08 Hours**

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

UNIT-III

Design of Electric and Hybrid Electric Vehicles	**10 Hours**

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.

Course Outcomes: At the end of the course student will be able to

1	Explain the roadway fundamentals, laws of motion, vehicle mechanics and propulsion system design
2	Explain the working of electric vehicles and hybrid electric vehicles in recent trends.
3	Model batteries, Fuel cells, PEMFC and super capacitors.
4	Analyze DC and AC drive topologies used for electric vehicle application.
5	Develop the electric propulsion unit and its control for application of electric vehicles.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2503-1.1	2	3	-	-	-	-	-	-	-	-	-	-
EE2503-1.2	1	2	3	-	-	-	-	-	-	-	-	-
EE2503-1.3	1	2	3	-	-	-	-	-	-	-	-	-
EE2503-1.4	1	2	3	-	-	-	-	-	-	-	-	-
EE2503-1.5	1	2	2	-	-	-	-	-	-	-	3	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
2	M. Ehsani, Y. Gao, S.Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2005.

REFERENCE BOOKS:

1	Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.
2	C.C. Chan and K.T. Chau, "Electric Vehicle Technology", OXFORD University, 2001
3	Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles Principles And Applications with Practical Perspectives", Wiley Publication, 2001

E Books / MOOCs/ NPTEL

1.	Introduction to Mechanics | Coursera
2.	Electric Vehicles - Part 1 - Course (nptel.ac.in)
3.	NPTEL: Electrical Engineering - Introduction to Hybrid and Electric Vehicles
4.	Hybrid Vehicles (edX) | MOOC List (mooc-list.com)
5.	Electric Cars: Technology | My MOOC (my-mooc.com)

FUNDAMENTALS OF PLC AND ITS APPLICATIONS

Course Code:	**EE2504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand main parts and their functions, basic sequence of operation of PLC.
2.	To study the different programming languages and fundamental wiring diagrams.
3.	To explain the functions of PLC counter instructions, applying combinations of counters and timers to control systems.
4.	To explain the basic operation of PLC closed-loop control system, various forms of mechanical sequencers and their operations
5.	To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes

UNIT-I

Programmable Logic Controllers	**02 Hours**
Introduction, Parts of a PLC, Principles of Operation, PLC Size and Application.	
PLC Hardware Components	**05Hours**
The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Human Machine Interface (HMIs).	
Basic Programming Language	**05Hours**
Ladder diagrams, Ladder conventions, Logic functions with timing diagram, latching, multiple outputs, entering programs, Functional blocks, Program examples, instruction list, branch codes, programming examples, Sequential functions charts, branching and convergence, actions, Structured Text, conditional and iteration statements	
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs	**03Hours**
Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description.	

UNIT-II

Programming Timers	**02 Hours**
Introduction, Necessity of Energy Storage and Methods of Energy Storage (Classification and brief description using block diagram representation)	
Programming Counters	**04 Hours**
Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions.	
Program Control Instructions	**05 Hours**

Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction.

Data Manipulation Instructions	**02 Hours**

Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control.

Math Instructions	**02 Hours**

Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations

UNIT-III

Sequencer and Shift Register Instructions	**05 Hours**

Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations.

Process Control, Network Systems, and SCADA	**05 Hours**

Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).

Course Outcomes: At the end of the course student will be able to

1.	Identify main parts, functions of PLC and describe basic circuitry for I/O modules to select PLC for desired application
2.	Apply suitable logic using various programming languages to achieve specific control mechanism for a given application
3.	Identify timer/counter resources of a PLC to design control logic for interfaced device.
4.	Interpret data manipulation and math instructions as they apply to a PLC program
5.	Develop programs that use shift registers and explain functions of control elements of a closed loop control system

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2504-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EE2504-1.2	1	3	-	-	-	-	-	-	-	-	-	-
EE2504-1.3	1	2	3	-	-	-	-	-	-	-	-	-
EE2504-1.4	1	2	3	-	-	-	-	-	-	-	-	-
EE2504-1.5	1	2	3	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Frank Petruzella, "Programming Logic Controllers", Fifth Edition.
2.	W Bolton, "Programmable Logic controllers", 6th edition, Elsevier- newness, 2015.

REFERENCE BOOKS:	
1.	John W Webb, Ronald A Reis, "Programmable logic controllers - principles and applications", 5th edition, 2nd impression, Pearson education, 2009
2.	L. A Bryan, E. A Bryan, "Programmable Controller Theory and Implementations", 2nd edition, 2003
3.	S. P. Sukhumi, J. K. Nayak, “Solar Energy: Principles Collection and Storage”, 3rd edition, McGraw-Hill Education (India) , 2009.
E Books / MOOCs/ NPTEL	
1.	https://library.automationdirect.com/category/product/programmable-control/
2.	https://www.coursera.org/lecture/intelligent-machining/programmable-logic-controllers-plc-fGz3r
3.	https://www.udemy.com/course/plc-programming-from-scratch/

MOTORS AND MOTOR CONTROL CIRCUITS

Course Code:	**EE2505-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Study architecture of induction motor and synchronous motor
2.	Understanding control of AC motor
3.	Study principle of operation of different dc motors
4.	Understand the different types of control techniques
5.	Study different sensors and their role in control of a motor

UNIT-I

AC Motor Designs	**08 Hours**

Introduction, Three phase AC motor architecture, Torque speed curve, wound rotor, Synchronous motors
Single phase AC motors, split phase motor, capacitor start and shaded pole motors, Universal and gear motors, AC Motor Specifications, Specifying an AC motor for an application.

AC Motor Control:	**07 Hours**

AC motor Enclosures, AC motor control components, Manual motor starting systems, Direct On Line Starter, semi-automatic star delta starter, fully automatic star delta starter, control circuit for sequence operation of two motors

UNIT-II

DC Motors	**07 Hours**

DC motor principle of operation, Brushed DC motors, shunt, series and compound wound motors, Brushless DC motors, driving a brushless DC motor, Commutation, Specifying a DC motor

DC Motor Control and Stepper Motors	**08 Hours**

Stepper motor principles of operation, Illustrative example of a stepper motor drive, stepper motor specification and operation, commercial stepper motor drive chips and packages, Direction Controller- H Bridge, Speed Controller: Pulse Width Modulation (PWM), Armature Controller: Variable resistance, DC vs.AC motors

UNIT-III

Sensors	**10 Hours**

Unipolar Hall Effect Switches, Omnipolar Hall Effect Switches, Latched Hall Effect Switches, Current Sensors: Shunt resistor, Current-sensing transformer, Hall effect current sensor, Speed/position sensors: Quadrature encoder, Hall effect tachometer, Back EMF/Sensorless control method, BLDC motor control with Hall sensor, Block diagram approach of BLDC Fan and Motor Control

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate an understanding of the general principles of AC Motor.
2.	Understand the basic principles of AC motor controls which includes starters, contactors, and control relays
3.	Demonstrate an understanding of the general principles of DC Motor.
4.	Understand the basic principles of DC motor controls which includes starters, contactors, and control relays
5.	Set up sensors in order to give feedback to a control circuit

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2505-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EE2505-1.2	2	3	3	-	-	2	-	-	-	-	-	-
EE2505-1.3	3	-	-	-	-	-	-	-	-	-	-	-
EE2505-1.4	2	3	3	-	-	2	-	-	-	-	-	-
EE2505-1.5	2	3	3	-	-	2	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	S. K. Bhattacharya Birjindersingh, "Control of electrical machines", New Age International.
2.	Gary J. Rockis & Glen A. Mazura, "Electrical Motor Controls", 5th Edition, ISBN number is 9780826912268

REFERENCE BOOKS:

1.	Stephen L. Herman, "Industrial Motor Control", Delmar Publishers, Inc., latest Edition.

E Books / MOOCs/ NPTEL

1.	https://www.coursera.org/learn/motors-circuits-design
2.	http://ww1.microchip.com/downloads/en/appnotes/00894a.pdf

NON-CONVENTIONAL ENERGY SOURCES

Course Code:	**EE2506-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-2**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the principle of extraction of energy from conventional, nonconventional sources
2.	To understand the working principle and applications of solar based thermal, electrical and PV systems.
3.	To justify the usage of energy storage techniques and understand the process of design and implement wind based energy conversion systems.
4.	To understand the process of design and implement biomass based energy conversion systems

UNIT-I

Energy Sources	**03 Hours**
Introduction, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Classification of Energy Resources, Conventional Energy Resources-Availability and their Limitations, Non-Conventional Energy Resources- Classification, Advantages, Limitations, Comparison of Conventional and Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario	
Solar Energy Basics	**05 Hours**
Introduction, Solar Constant, Basic Sun-Earth Angles – definitions and their representation, Solar Radiation Geometry (numerical problems), Estimation of Solar Radiation of Horizontal and Tilted Surfaces (numerical problems), Measurement of Solar Radiation Data – Pyranometer and Pyrheliometer	
Solar Thermal Systems	**04 Hours**
Principle of Conversion of Solar Radiation into Heat, Solar Water Heaters (Flat Plate Collectors), Solar Cookers – Box type, Concentrating dish type, Solar driers, Solar Still, Solar Furnaces, Solar Green House.	
Solar Electric Systems	**04 Hours**
Solar Thermal Electric Power Generation, Solar Pond and Concentrating Solar Collector(Parabolic Trough, Parabolic Dish, Central Tower Collector), Advantages and Disadvantages; Solar Photovoltaic – Solar Cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems- stand-alone and grid connected, Applications- Street lighting, Domestic lighting and Solar Water pumping systems.	

UNIT-II

Energy Storage	**04 Hours**
Introduction, Necessity of Energy Storage and Methods of Energy Storage (Classification and brief description using block diagram representation)	

Wind Energy	**04 Hours**
Introduction, Wind and its Properties, History of Wind Energy Wind Energy Scenario – World and India. Basic principles of WECS, Classification, Parts of a WECS, Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS. Wind site selection consideration, Advantages and Disadvantages of WECS.	
Biomass Energy	**06 Hours**
Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, Factors affecting biogas generation, types of biogas plants- KVIC and Janata model, Biomass program in India	
UNIT-III	
Energy From Ocean	**05 Hours**
Tidal Energy – Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plant, Estimation of Energy – Single basin and Double basin type TPP (no derivations, Simple numerical problems), Advantages and Limitation of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle), Hybrid cycle, Site-selection criteria, Biofouling, Advantages & Limitation of OTEC	
Emerging Technologies	**05 Hours**
Fuel Cell, Small Hydro Resources, Hydrogen Energy and Wave Energy (Principle of Energy generation using block diagrams, advantages and limitations)	

Course Outcomes: At the end of the course student will be able to

1.	Describe non-conventional energy sources and solar radiation geometry to estimate and measure solar radiation.
2.	Apply the principle of solar radiation into heat to understand the operation of solar thermal and solar electric systems.
3.	Describe energy storage methods and wind–energy conversion systems to understand the factors influencing power generation.
4.	Review the biomass conversion technologies to design biomass-based energy systems.
5.	Describe tidal, ocean thermal and fuel cell energy conversion systems to understand emerging non-conventional energy technologies.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2506-1.1	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.2	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.3	2	3	-	-	-	1	2	1	-	-	-	-

EE2506-1.4	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.5	2	3	-	-	-	1	2	1	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Rai G. D., "Non-Conventional Sources of Energy", 4th Edition, Khanna Publishers, New Delhi, 2007.

REFERENCE BOOKS:

1.	Mukherjee D. and Chakrabarti, S., "Fundamentals of Renewable Energy Systems", New Age International Publishers, 2005.
2.	Khan, B. H., "Non-Conventional Energy Resources", TMH, New Delhi, 2006.
3.	S. P. Sukhumi, J. K. Nayak "Solar Energy: Principles Collection and Storage", 3rd edition, McGraw-Hill Education (India) , 2009.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108108078

ELEMENTS OF YOGA

Course Code:	**HU1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To give a brief history of the development of Yoga
2.	Identify names of different classical texts on Yoga
3.	To illustrate how Yoga is important for healthy living
4.	To explain the Asanas and other Yogic practices
5.	To explain, how Yoga practices can be applied for overall improvement

UNIT-I

Yoga	**09 Hours**

Meaning and initiation, definitions and basis of yoga, History and development, Astanga yoga, Streams of yoga. Yogic practices for healthy living.
General guidelines for Yoga practices for the beginners: Asanas, Pranayama.

Classification of Yoga and Yogic texts	**07 Hours**

Yogasutra of Patanjali, Hatha yogic practices- Asanas, Pranayama, Dharana, Mudras and bandhas.

UNIT-II

Yoga and Health	**06 Hours**

Concept of health and Diseases-Yogic concept of body – pancakosa viveka, Concept of disease according to Yoga Vasistha.

	04 Hours

Yogic concept of healthy living- rules & regulations, yogic diet, ahara, vihara. Yogic concept of holistic health.

Applied Yoga for elementary education	**04 Hours**

Personality development- physical level, mental level, emotional level. Specific guidelines and Yoga practices for - Concentration development, Memory development

UNIT-III

Yoga and physical development	**05 Hours**

Mind-body, Meditation, Yogasanas and their types. Different Yoga practices and Benefits.

	05 Hours

Specific guidelines and Yoga practices for – Flexibility, Stamina, Endurance (Surya Namaskara)

Course Outcomes: At the end of the course student will be able to

1.	Understand a brief history of the development of Yoga
2.	Know important practices and principles of Yoga
3.	Explain how Yoga is important for healthy living
4.	Practice meditation to improvement of concentration etc.
5.	Have knowledge about specific guidelines of yoga practices

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1501-1.1	-	-	-	-	-	1	-	-	1	-	-	1
HU1501-1.2	-	-	-	-	-	1	-	-	1	-	-	3
HU1501-1.3	-	-	-	-	-	2	-	-	1	-	-	3
HU1501-1.4	-	-	-	-	-	3	-	-	2	-	-	3
HU1501-1.5	-	-	-	-	-	2	-	-	2	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B. K. S. Iyengar, "Light on Yoga: The Classic Guide to Yoga by the World's Foremost Authority", Thorsons publisher 2016.
2.	Makarand Madhukar Gore, "Anatomy and Physiology of Yogic Practices: Understanding of the Yogic Concepts and Physiological Mechanism of the Yogic Practices", Motilal Banarsidass Publishers; 6 edition (2016).
3.	Swami Satyananda Saraswati, "Asana, Pranayama, Mudra and Bandha: 1", Yoga Publications Trust.

REFERENCE BOOKS:

1.	Ann Swanson, "Science of Yoga: Understand the Anatomy and Physiology to Perfect Your Practice".
2.	Dianne Bondy, "Yoga for Everyone : 50 Poses For Every Type of Body".

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.swayam2.ac.in/aic19_ed29/preview
2.	https://youtu.be/FMf3bPS5wDs

INTELLECTUAL PROPERTY RIGHTS

Course Code	**HU1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Understand the creativity component in intellectual property, different types of legal protection of intellectual properties and other basic concepts of Intellectual property.
2.	Analyze different types of protection for inventions, different types of agreements and treaties for Intellectual properties with an ability to examine patent types, specifications and patent search and database for 'prior art'.
3.	Understand the basic procedure of drafting claims, apply for patents, other legal forms of intellectual property rights and also to examine the protocol involved in protection of inventions like patents.

UNIT - I

Introduction to Intellectual Property	**08 Hours**

Invention and Creativity - Intellectual Property (IP) – Importance, Jurisprudential definition and concept of property, rights, duties and their correlation; History and evaluation of IPR – like Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications.

Agreements and Treaties	**08 Hours**

History - General Agreement on Trade and Tariff (GATT). Indian Position vis-a-vis WTO and Strategies; TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; International convention relating to Intellectual Property - Establishment of WIPO - Mission and Activities – Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments – Patent (Amendment) Rules, 2017

UNIT - II

Basics of Patents and Concept of Prior Art	**08 Hours**

Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in the context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, WIPO, IPO, etc.)

Patent filing procedures	**08 Hours**

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Structure of Patent document, Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies.

UNIT - III	
Case Studies	**08 Hours**
Patents: Biological Cases - i) Basmati rice ii) Turmeric iii) Neem; Non-biological cases – (i) TVS V/S Hero, (ii) Samsung V/S Nokia – Copyright and related rights – Trade Marks – Trade secrets - Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition; Technology transfer and license agreements (US anti-HIV drug license to Africa).	

Course Outcomes: At the end of the course student will be able to

1.	Have a General understanding of the Intellectual Property Rights.
2.	Have awareness of different forms of intellectual property rights, national and international IPR related legislations.
3.	Have a general understanding about the provisions, privileges and limitations of intellectual property right holders with an understanding of the legal aspects (civil or criminal) of the use of intellectual property rights.
4.	Acquire Knowledge of National and International Trade Agreements and Agencies functioning in relation to intellectual property rights
5.	Be aware and have a general understanding of patenting procedures and licensing.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ **Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1502-1.1	-	3	3	2	-	3	-	-	2	2	-	3
HU1502-1.2	2	2	3	-	-	3	-	3	1	1	2	2
HU1502-1.3	2	-	-	2	-	3	-	-	2	2	2	3
HU1502-1.4	-	-	1	1	-	3	-	-	1	2	-	3
HU1502-1.5	3	2	1	-	-	3	-	-	3	1	-	2

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	BAREACT, "Indian Patent Act 1970 Acts & Rules", Universal Law Publishing Co. Pvt. Ltd., 2007.
2.	Kankanala C., "Genetic Patent Law & Strategy", 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.
3.	Subbaram N.R., "Handbook of Indian Patent Law and Practice", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.
4.	Eli Whitney, United States Patent Number: 72X, Cotton Gin, March 14, 1794.
5.	Intellectual Property Today: Volume 8, No. 5, May 2001.
6.	M B Rao, "WTO and International Trade", Vikas Publishing House Pvt. Ltd.
7.	Correa, Carlos M. "Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options", Zed Books, New York 2000.
8.	Wadehra, B. L. "Law relating to patents, trademarks, copyright designs & geographical indications", 2 ed. Universal Law Publishing 2000.

9.	Sinha, Prabhas Chandra, "Encyclopedia of Intellectual Property Rights", 3 Vols. Eastern Book Corporation, 2006.
10.	Rachna Singh Puri and Arvind Vishwanathan, “Practical Approach to Intellectual Property Rights”; I. K. International Publishing House Pvt. Ltd.
E-RESOURCES:	
1.	http://www.w3.org/IPR/
2.	http://www.wipo.int/portal/index.html.en
3.	http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
4.	www.patentoffice.nic.in
5.	www.iprlawindia.org/

INTRODUCTION TO GERMAN LANGUAGE

Course Code	HU1503-1	Course Type	OEC
Teaching Hours/Week (L:T:P: S)	3:0:0:0	Credits	03
Total Teaching Hours	40+0+0+0	CIE + SEE Marks	50+50

Teaching Department: Mechanical

Course Objectives:

1.	Distinguish - definite and indefinite articles, declension of singular and plural nouns by adding certain endings to them to differentiate between subjects, objects and indirect objects and construct sentences of simple day to day usage.
2.	Differentiate between nomnative and akkusative cases with transitive and intransitive verbs, and negation with Kein/e/er
3.	Differentiate use of dative object besides the subject for some specific verbs and Apply the grammar principles of use of personal pronoun as a substitute for noun as per the case, number and gender of the noun.
4.	Differentiate preposition forms when used exclusively in akkusative or Dative forms or on combination of the two cases
5.	Differentiate conjugation of verbs in present, present-perfect and past participle tenses, separable and inseparable verbs, application of conjugation of modal verbs and position of modal verb in a sentence.

UNIT - I

15 Hours

Introduction: Mein Name ist (saying who you are, greeting people and saying goodbye, asking people where they come from and where they live. Language point: I and you), Lesen der politischen Karte der Welt, Nationalitaeten und Spachen, Die Uhrzeit (The time) telling time and talking about daily routine, Tage der Woche, die Monate, die vier Jahreszeiten, die Jahre

Mir geht es gut: Asking people how they are, saying how you are, saying which cities and counries people come from, Language points: verb endings),

Wie schreibt man das (how do you write that?) Counting from 1-100 and above, alphabet, spelling our names and words, talking about us and them. Language points: Yes-no questions

Artikel (Articles): As in English, there are definite (der/die/das) and indefinite (ein/eine) articles:

the · der/die/das; a/an · ein/eine

Die vier Fälle (The four cases): Nominativ, Akkusativ, Dativ, Genitiv(Not in level A-1)

Deklination des bestimmten Artikels der/die/das

Deklination des unbestimmten Artikels ein/eine

(Deklination/Declension: the variation of the form of a noun, pronoun, or adjective, by which its grammatical case, number, and gender are identified)

Deklination von Substantiven (Declension of nouns) (Singular and Plural)

(German nouns are declined by attaching certain endings to them, according to case, number and gender. This helps to differentiate between subjects, objects and indirect objects).

Nominativ und Akkusativ(nominative and accusative cases)
The verb determines the case of the noun. Some verbs only go with the nominative, others only with the accusative (or the dative). Thus, German verbs are either transitive or intransitive.
(Nominative and accusative cases) Intransitive Verben (intransitive verbs) Transitive Verben (transitive verbs)

Negation „kein/e/er "(negation with „kein/e/er ")
(Singular und Plural)
The negation of the indefinite article (ein/eine/ein) is kein/keine/kein. For this, you just have to put a „k" at the beginning of the declined form of ein/eine/ein.
Peter sieht ein Haus. · Negation · Peter sieht kein Haus.
(Peter sees a house. · negation · Peter does not see a house.)

(With examples, writing and hearing exercises, and German to English Glossary as applicable)

UNIT - II

14 Hours

Dativ (the dative)
(You are already familiar with verbs which require a direct accusative object in addition to the subject, which is in the nominative case. But there also some verbs which require a dative object besides the subject. To identify the dative object you ask "(To) whom?")

Der Plural (the plural)
There are many different forms of the plural in the German language. Principally, the gender and the ending of the noun determine the plural form. Then, you either attach a plural ending
to the noun, change a vowel, or keep the noun as it is in the singular.

Das Personalpronomen (the personal pronoun)
The personal pronoun is a substitute for a noun. Its forms are determined by the case, number and gender of the noun which is to be replaced.

Die Formen des Personalpronomen im Nominativ
(The nominative forms of the personal pronoun):

Präpositionen (prepositions)
German prepositions are followed by an object, either in the accusative or the dative case.Some prepositions always take an accusative object, others always a dative object. But

thereare also prepositions which can be followed by both. In this case, the question "Where(to)?"
(· accusative) or "Where?" (· dative) determines the case of the object.

Präpositionen mit Akkusativ und Dativ
(Prepositions with accusative and dative)
1.Präpositionen mit Akkusativ (prepositions with accusative)
2.Präpositionen mit Dativ (prepositions with dative)
3.Präpositionen mit Akkusativ oder Dativ (prepositions with accusative or dative)

(With examples, writing and hearing exercises, and German to English Glossary as applicable)

UNIT - III	
	11 Hours

Konjugation von Verben im Präsens
(Conjugation of verbs in present tense)
Verbs are conjugated by attaching certain endings, depending on the person and number ofthe subject.

Trennbare und untrennbare Verben
(separable and inseparable verbs)
Verbs with prefixes are dinstinguished between separable and inseparable verbs.
The prefix of an inseparable verb must never be separated from the stem. Here the stress is on the stem: be-kommen. The prefix of a separable verb gets separated from the stem when the verb is conjugated. In the infinitive, the stress is on the prefix: an-kommen
1.Trennbare Verben (separable verbs)
2.Untrennbare Verben (inseparable verbs)

Konjugation von Verben im Perfekt
(Conjugation of verbs in present perfect)
The present perfect (Perfekt) describes something which happened in the past and isespecially used in spoken German. It is formed with the present tense form of „haben" or „sein" and the past participle of the main verb.
1. Die Bildung des Partizips
(the formation of the past participle)
2. Die Bildung des Perfekts mit „haben" und „sein"
(the formation of the present perfect with „haben" and „sein")

Modalverben (modal verbs)
A modal verb is rarely used as a main verb; instead, it usually modifies the main verb. Whilethe main verb remains in the infinitive, the modal verb is conjugated.
In German, there are 7 modal verbs:
können (can/be able), dürfen (may/be allowed), wollen (want),

müssen (must/have to), sollen (shall), mögen (to like), möchten (wish/would like)

1. Konjugation der Modalverben
(Conjugation of the modal verbs)
2. Stellung des Modalverbs im Satz
(Position of the modal verb within a sentence)

(With examples, writing and hearing exercises, and German to English Glossary as applicable)

Course Outcomes: At the end of the course student will be able to

1.	Distinguish - definite and indefinite articles, declension of singular and plural nouns by adding certain endings to them to differentiate between subjects, objects and indirect objects and construct sentences of simple day to day usage.
2.	Differentiate between nomnative and akkusative cases with transitive and intransitive verbs, and negation with Kein/e/er
3.	Differentiate use of dative object besides the subject for some specific verbs and Apply the grammar principles of use of personal pronoun as a substitute for noun as per the case, number and gender of the noun.
4.	Differentiate preposition forms when used exclusively in akkusative or Dative forms or on combination of the two cases
5.	Differentiate conjugation of verbs in present, present-perfect and past participle tenses, separable and inseparable verbs, application of conjugation of modal verbs and position of modal verb in a sentence.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12
↓ Course Outcomes												
HU1503-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

TEXT BOOKS:

1.	Ulrich Haessermann, Georg Dietrich, Christianne C. Guenther, Diethelm Kaminski, Ulrike Woods and Hugo Zenker, Sprachkurs Deutsch Neusaffung 1, Unterrichtswerk fuer Erwachsene, Verlag Moritz Diesterweg, Universitaetsdruckerei H. Stuertz AG Wuerzburg, 1989.
2.	Paul Coggle and Heiner Schenke, Teach Yourself German (a complete course in understanding, speaking and writing), Teach Yourself Books, Hodden & Stoughton Educational, UK, 2001
3.	Langenscheidt German In 30 Days: Book + Cd Paperback, www.amazon.in, – 1 September 2011

REFERENCE MATERIALS:	
1.	Deutsche Sprachlehre für Ausländer.
2.	Themen Aktuell (Text and workbook).
3.	Deutsch als Fremdsprache 1A.
4.	Tangram Aktuell 1A/1B (Text and workbook).
5.	Wherever required the Videos/Audios are also played in the class room sessions
E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/noc21_hs30/preview NPTEL-Swayam, German-I by Prof. Milind Brahme | IIT Madras
2.	https://www.traingerman.com/en/ powered by Sprachinstitut TREFFPUNKT Online

INTRODUCTION TO JAPANESE LANGUAGE

Course Code	**HU1504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department:

Course Objectives:

1.	Have basic spoken communication skills
2.	Write Simple Sentences
3.	Listen and comprehend basic Japanese spoken Japanese
4.	Read and understand basic Japanese characters including Kanji

UNIT - I

(Lessons 1-6) — **15 Hours**

Grammar – Introduction, Alphabets, Accents, Noun, Pronoun, Present Tense, Past tense
Vocabulary – Numbers, Days, week days, months, Seasons, Nature, Dialogs and Video Clips

UNIT - II

(Lessons 7-13) — **14 Hours**

Communication skills – Time, Addective, Seasons, Conversation, Q&A, Hobby, 5-W/1-H, Entering School/Company, Body Parts, Colours, Features etc**.**

UNIT - III

(Lessons 14-20) — **11 Hours**

Japanese Counting System, Birth/Death, Dialogs (Going to Party, Restaurant), My day, Success/Failure, Kanji Characters, and sentence making, Video Clips

Course Outcomes: At the end of the course student will be able to

1.	Understand Simple words, expressions and sentences, spoken slowly and distinctly
2.	Speak slowly and distinctly to comprehend
3.	Read and Understand common words and sentences
4.	Ask Basic questions and speak in simple sentences
5.	Write Hiragana/Katakana and Kanji (120) characters.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1504-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

NATIONAL CADET CORPS: ORGANIZATION, FUNCTIONS AND CAPABILITIES

Course Code	**HU1505-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Chemistry

Course Objectives:

1.	To create evolved youth, who will be equipped to contribute in the development of the nation.
2.	To train students so as to achieve their physical and mental endurance. To acquire body language of smart soldier and to inculcate the sense of authority by commanding the troop under him/her.
3.	To inculcate spirit of adventure, undertake adventure activities, to hone leadership qualities and risk-taking abilities.
4.	To understand and develop life skills, soft skills and to improve emotional quotient of the student.
5.	To impart basic military training, to develop awareness about the defense forces and expose learners to military ethos / values

UNIT - I

NCC: Aims, Objectives and Organization	**07 Hours**
NCC General, Aims, Objectives and Organization of NCC. Duties of NCC Cadets, NCC Camps: Types and Conduct. National Integration: Importance and Necessity, Unity in Diversity.	
Personality Development	**07 Hours**
Self-Awareness, Empathy, Critical and Creative Thinking, Decision Making and Problem Solving. Communication Skills, Coping with stress and emotions. Leadership: Traits, Indicators, motivation, moral values, Honor Code. Social Service and Community Development.	

UNIT - II

Naval Communication and Seamanship	**08 Hours**
Naval Communication: Introduction, Semaphore, Navigation: Navigation of Ships- Basic requirements, Chart work. Seamanship: Introduction to Anchor work, Rigging Capsule, Boat work- Parts of Boat, Boat pulling instructions, Whaler sailing instructions. Ship Modeling.	
Disaster management and environmental awareness	**08 Hours**
Disaster Management- Organization, Types of Disasters, Essential Services, Assistance, Civil Defence organization. Adventure Activities. Dos and Don'ts, Fire services and Firefighting, Environmental Awareness and Conservation.	

UNIT - III	
Naval Orientation	**10 Hours**

Naval Orientation- Armed Forces and Navy Capsule, EEZ Maritime Security & ICG. Border & Coastal Areas: Security setup and Boarder/Coastal management in the area. Naval Orientation: Modes of Entry- IN, ICG, Merchant Navy.
Border and Coastal areas: Security Challenges & role of cadets in Border management

Course Outcomes: At the end of the course student will be able to

1.	Display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.
2.	Demonstrate the sense of discipline, improve bearing, smartness, turnout and develop the quality of immediate and implicit obedience of orders, with good reflexes.
3.	Acquaint, expose & provide knowledge about Army/Navy/ Air force and acquire information about expanse of Armed Forces, service subjects and important battles.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO ↓**	
↓ Course Outcomes													1	2
HU1505-1.1	-	-	-	-	-	3	3	1	-	-	-	-	-	-
HU1505-1.2	-	-	-	-	-	3	3	-	-	-	-	-	-	-
HU1505-1.3	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	R.K. Guptha, "Cadets Handbook", Ramesh Publishing House, New Delhi.

OVERVIEW OF INDIAN CULTURE

Course Code	**HU1506-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	To understand the relevance of Culture in Human Life, dynamism of Indian Culture and Arts through ages.
2.	To understand the local culture and its vibrancies.
3.	To develop awareness about Indian Society, Culture and Arts under Western rule.
4.	To comprehend different dimension and aspects of the Indian culture and arts.
5.	To appreciate cultural performances in India.

UNIT - I

Knowing Culture	**08 Hours**
What is Culture, Different aspects of Culture, Cultural expression, Importance of Culture	
Influence of Culture	**07 Hours**
Relationship of Culture with: Language, Religion and History, Gender	

UNIT - II

Media and Culture	**07 Hours**
Role of News Papers, Indian Cinema, Music, Advertisements	
Languages, Literature and Culture	**07 Hours**
Role of Sanskrit, Vedas, Upanishads, Ramayana and Mahabharata, Puranas, other Sanskrit Literature, Buddhist and Jain Literature, Dravidian Languages and Literature, North Indian Languages and Literature, Subaltern Literature	

UNIT - III

Arts and Culture	**07 Hours**
Indian Theatre and Performing Arts, Ritual performances, and Tuluva cultural and ritual performances.	
(Self-study Component) **Contribution of Indian History to Culture**	**04 Hours**

Ancient India – Persian and Macedonian invasions and its impact on Indian Culture, Development of Culture and Arts during the Mauryan Empire (Ashoka), the Guptas, the South Indian Dynasties – the Cholas, Nalanda as a Centre of Learning.
Medieval India – Life of People under Delhi Sultanate, Rise of Islam and Sufism, Political Scene of India, Bhakti Movement, Folk Arts, Rise of Modern Indian Languages.
Modern India – British Ruling and its impact on Indian Culture, Social and Religious Reforms, Indian National Movement and Achievement of Independence.

Course Outcomes: At the end of the course student will be able to

1.	Examine how the culture has a very important role in human life and growth of human civilization and have a general awareness on historical perspective of growth of Indian Culture and Arts.
2.	Appreciate their own local culture from an academic perspective.
3.	Know about the impact of Western Rule in India and Indian Struggle for Freedom and also its impact on Indian Culture and Arts and able to appreciate and the role of language in connecting people, growth of culture and arts beyond the barriers of religion and ages.
4.	Take interest in learning these forms of arts, and also appreciate and preserve them for the future generations feeling proud of Indian Culture, Arts and Architecture.
5.	Appreciate art performances in India which will enable them to get exposed to an artistic sphere, which eventually help them to be creative and imaginative.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1506-1.1	-	1	-	-	-	3	-	3	3	1	-	3
HU1506-1.2	-	-	-	2	-	3	-	2	3	3	-	3
HU1506-1.3	-	-	-	-	-	3	-	1	-	-	-	1
HU1506-1.4	-	-	-	-	-	3	-	2	1	2	-	3
HU1506-1.5	-	-	-	-	-	3	-	3	3	3	-	2

1: Low 2: Medium 3: High

PHILOSOPHY

Course Code	**HU1507-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Visiting

Course Objectives:

1.	To provide a new understanding based on which one can move to overcome the current problems, both at the individual level as well as at the societal level.
2.	To introduce an orientation course for humanities courses in general and for philosophy courses in particular.
3.	To relate philosophy to literature, culture, society and lived experience.
4.	To train students in already available philosophical systems.
5.	To bridge the gap between theory and practice.

UNIT - I

Knowledge (Vidya) and Ignorance (Avidya)	**14 Hours**

Upanishads
Six systems orthodox and Heterodox schools of Indian philosophy
Greek philosophy

Origin of the universe

NasidiyaSukta: "Who really knows?"
Brhadaranyaka Upanishad; Chandogya Upanishad: Non-Self, real and unreal
Taithriya Upanishad: SikshaValli
Plato's Symposium: Lack as the source if desire and knowledge.
Socratic method of knowledge as discovery
Language: word as root of knowledge (Bhartrahari's Vakyapadiyam)
Fourteen Knowledge basis as a source of Vidya: Four Vedas, six auxiliary sciences (vedangas); Purana, Nyaya, Mimamsa and Dharma Sastras.

UNIT - II

Knowledge as Power	**16 Hours**

Francis Bacon. Knowledge as both power and self- realization in Bhagavad Gita.

Knowledge as Oppression

M. Foucault. Discrimination between Ram and Satyam in Indian Philosophy.

Knowledge as Invention

Modern definition of creativity; scientific activity in the claim that science invents new things at least through technology.

UNIT - III

	10 Hours

Knowledge about the self, transcendental self; knowledge about society, polity and nature
Knowledge about moral an ethics codes.

Course Outcomes: At the end of the course student will be able to

1.	To provide a new understanding based on which one can move to overcome the current problems, both at the individual level as well as at the societal level.
2.	To introduce an orientation course for humanities courses in general and for philosophy courses in particular.
3.	To relate philosophy to literature, culture, society and lived experience.
4.	To train students in already available philosophical systems.
5.	To bridge the gap between theory and practice.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1507-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	Copleston, Frederick, "History of Philosophy", Vol. 1. Great Britain: Continuum.
2.	Hiriyanna, M. , "Outlines of Indian Philosophy", Motilal Banarsidass Publishers; Fifth Reprint edition, 2009.
3.	Sathaye, Avinash, "Translation of Nasadiya Sukta".
4.	Raju, P. T. "Structural Depths of Indian Thought", Albany: State University of New York Press.
5.	Plato, Symposium, Hamilton Press

PRINCIPLES OF PHYSICAL EDUCATION

Course Code	**HU1508-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Physical Education

Course Objectives:

1.	Express understanding of constitution of sports organizations
2.	Demonstrate considerate familiarity of various food practices
3.	Grasp understanding of first aid and physical education
4.	Awareness on the importance of exercise
5.	Leadership skills and the rules of different sports

UNIT - I

15 Hours

History of Physical Education - Olympic games, Modern Olympic games, Olympic Ideals & Objectives, Olympic Symbols, Olympic Flag, Olympic Emblem, Olympic Motto, Olympic Flame, Asian games
International Olympic Committee (IOC), Indian Olympic Association (IOA)
Sports awards - Eligibility, Objectives & Criteria
Yoga - Meaning and Importance
World Health organization (WHO)

UNIT - II

14 Hours

Concept of Health - Meaning of Health, Health Definition, Factors Affecting Health, Qualities of Healthy Person. Health Hazards of College Students, Physical Fitness and Exercises.
Food and Nutrition - Food & Nutrition Defined, Nutrients and their Functions - i) Proteins ii) Carbohydrates iii) Fats iv) Vitamins
Balanced Diet & Malnutrition
Health Education - Meaning of Health Education, Health Education Defined, Scope of Health Education, Importance of Health Education.
Posture - Concept of Posture, Correct Postures, Common Postural Defects
First Aid - First Aid Defined, Need and importance of First Aid, The Requisites of First Aid, Scope of First Aid, Qualities of a First Aider, Fundamental Principles to be followed and the Duties to be performed by the First Aider, First Aid in Different Cases.
Physical Education - Concept of Physical Education, Physical Education Defined, Importance of Physical Education, Scope of Physical Education, Aims and Objectives of Physical Education.
Teaching Aid in Physical Education
Competition - Introduction, Types of competition, Knock out, League or Round Robin Tournament.

UNIT - III	
	11 Hours
Training in Sports – Meaning, Principles, Warming Up & Limbering Down Importance of Anatomy and Physiology in Physical Education, Oxygen Debt and Second wind Leadership and Supervision – Leadership, Qualities of a good leader in Physical Education, Types of Leadership in Physical Education - 1. Teacher Leadership 2. Student Leadership. Measurement & specification of various playing fields – Cricket, Volley Ball, Basket Ball, Badminton, Ball Badminton, Foot Ball, Hand Ball & their basic playing skills.	

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate knowledge of structure of the world sports organizations
2.	Display understanding of different type of food and nutrition for a healthy diet
3.	Comprehend awareness of first aid and physical education
4.	Elucidate about training and the importance of Physical Education
5.	Aware of leadership skills and the knowledge of various sports

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1508-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

COMMON SENSE AND CRITICAL THINKING

Course Code	**HU2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Pre-requisite	**HU1001-1 (Technical English)**		

Teaching Department: Humanities

Course Objectives:

1.	To Problematize Commonsense & Apply Critical thinking skills
2.	Comprehend etiquettes and manners in different situations
3.	Be gender sensitive in both offline and online behavior
4.	Exhibit better comprehension of the social implications of human body
5.	Understand the importance of reading and writing skills

UNIT - I

Common sense and Emotional Intelligence	**15 Hours**
Common sense, Commonsensical Consensus, Critical thinking, Unsettling commonsensical Consensus, Role of language in Common sense and Critical Thinking;Nature & Functions of Emotional Intelligence, Emotions, Intelligence and Creativity, Growth of Emotional Intelligence	
Etiquettes & Workplace	
Etiquette, Workplace Etiquettes, Workplace Readiness Skills, Significance of Cross-Cultural Understanding; Cultural Sensitivity, Impact of social media in Workplace	

UNIT - II

Social Networking Sites and its Impacts	**15 Hours**
Emergence of social media, Impact on Gender and Self Representation, Regulatory and Liberatory aspects of social media, Offline Norms & Online Behaviour	
Gender and Body	
Gender & Sex, Genderization, Homogeneity and Heterosexuality, Gender Expressions, Gender Schooling, Representations of Body, Objectification, Gender Perspectives of Body, Different Ways of Seeing the Body, Discipline & Coercion, ISA & RSA	

UNIT - III

Writing	**10 Hours**
Types of Writing, Note Taking Methods, Plagiarism	
Reading	
Styles of Reading, Types of Reading, Scanning, Skimming	

Course Outcomes: At the end of the course student will be able to

1.	Problematize Commonsense & Apply Critical thinking skills
2.	Comprehend etiquettes and manners in different situations
3.	Be gender sensitive in both offline and online behavior
4.	Exhibit better comprehension of the social implications of human body
5.	Understand the importance of reading and writing skills

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
HU2501-1.1	-	3	-	-	-	-	-	-	3	3	-	3
HU2501-1.2	-	2	-	-	-	-	-	3	2	3	-	2
HU2501-1.3	-	3	-	-	-	-	-	-	2	2	-	3
HU2501-1.4	-	3	-	-	-	-	-	-	2	2	-	3
HU2501-1.5	-	2	-	-	-	-	-	-	3	3	-	2

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	Geetha.V. Gender. Kolkatta: Web Impressions, 2009.
2.	Bailey, Jane, et al. "Negotiating with Gender Stereotypes On Social Networking Sites: From "Bicycle Face" to Facebook." Journal of Communication Enquiry 37.2 (2013): 91-112.
3.	Barry, Peter. "Beginning Theory". New Delhi: Viva Books, 2010.
4.	Berger, John. "Ways of Seeing". London: Penguin Books, 1977.
5.	Cranny-Francis, Anny, et al. "Gender Studies: Terms and Debates". New York: Palgrave Macmillan, 2003.
6.	Gauntlett, David. "Media, Gender and Identity: An Introduction". London: Routledge, 2008
7.	Pilcher, Jane, and Imelda Whelehan. "50 Key Concepts in Gender Studies". London: Sage, 2004. Print.
8.	Jeanne, Haraway Donna. Simians, Cyborgs, and Women. London: Free Association Books, 1991. Web.
9.	Koskela, Hille. "Webcams, TV Shows and Mobile Phones: Empowering Exhibitionism." Surveillance & Society 2.3 (2004): 199-215.Web.

E-RESOURCES:

1.	http://www.cyberpsychology.eu/view.php?cisloclanku=2009061501/ >.
2.	http://www.surveillance-and-society.org/articles2(2)/webcams.pdf
3.	http://eprints.rclis.org/19790/>.

LINGUISTICS & LANGUAGE TECHNOLOGY

Course Code	**HU2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Pre-requisite	**HU1001-1 (Technical English)**		

Teaching Department: Humanities

Course Objectives:

1.	Introspect about the consciousness in one's language
2.	Learn pronunciation and how the process helps to communicate effectively.
3.	Build contextual speech and writing with the pedagogy in sentence structure.
4.	Improve skill of applying language to enunciate words.
5.	Progress on the speech aspects by understanding the acquisition of Second Language.

UNIT - I

Introduction to Linguistics — **08 Hours**

Broad understanding of Linguistics, Language and characteristic features, Scientific Language, Levels of Linguistic Analysis (Phonetics, Phonology, Morphology, Syntax and Semantics); Approach to Linguistics (Traditional, Structural and Cognitive).

Phonology and Morphology — **08 Hours**

Perspectives in Linguistics, Phonemes, Allophones, Phonemic Analysis, Morphology and Morphemes, Word building process, Morphological Analysis.

UNIT - II

Syntax — **16 Hours**

Constituent structure (Simple Sentence, Noun Phrase, Verb Phrase, Prepositional Phrase, Adjective Phrase, Adverb Phrase, Structure Rules), Tree Diagrams, Case

UNIT - III

Sociolinguistics & Psycholinguistics, Artificial Intelligence — **08 Hours**

Notion of Language Variety, Languages in Contact, Language and Mind, Error Analysis.

Course Outcomes: At the end of the course student will be able to

1.	Understand the importance of language and its facets.
2.	Demonstrate knowledge of sounds and competence in process of word building.
3.	Evolve to reason the constituent parts of a sentence.
4.	Understand the techniques of how 'meaning' is applied.
5.	Analyze errors in day-to-day-conversations and how language is related to society.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
HU2502-1.1	-	1	-	-	1	1	-	-	1	-	-	2
HU2502-1.2	-	-	2	-	-	-	-	-	2	2	-	-
HU2502-1.3	2	3	-	3	-	-	-	-	3	2	-	-
HU2502-1.4	-	-	-	-	2	-	-	-	1	2	-	-
HU2502-1.5	-	2	-	-	-	2	1	-	-	-	-	1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. Akmaijan, A, R. A. Dimers and R. M. Harnish. "Linguistics: An Introduction to Language and Communication". London: MIT Press, 1979.

2. Chomsky, Noam. "Language in Mind". New York: Harcourt Brace Jovanovich, 1968.

3. Fabb, Nigel. "Sentence Structure". London: Routledge, 1994.

4. Hockett, C. "A Course in Modern Linguistics". New York: Macmillan, 1955.

5. O'Grady, W., O. M. Dobrovolsky and M. Aronoff. "Contemporary Linguistics: An Introduction". New York: St. Martin's Press, 1991.

6. Pride, J. B. and J. Holmes. "Sociolinguistics". Harmondsworth: Penguin, 1972.

7. Richards, J. C. "Error Analysis: Perspectives in Second Language Acquisition". London: Longman, 1974.

8. Salkie, R. "The Chomsky Update: Linguistics and Politics". London: Unwin Hyman Ltd., 1990.

9. Sinclair, J. M. C. H. and R. M. Coulthard. "Towards an Analysis of Discourse". Oxford: OUP, 1975.

10. Thomas, Linda. "Beginning Syntax". Oxford: Blackwell, 1993.

11. Verma, S. K. and N. Krishnaswamy. "Modern Linguistics: An Introduction". New Delhi: OUP, 1989.

12. Wekker, Herman and Liliane Haegeman. "A Modern Course in English Syntax". Kent: Croom Helm, 1985.

INTRODUCTION TO CYBER SECURITY

Course Code:	**IS2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**IS1651-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Define the area of cybercrime and forensics and to understand the security threat
2.	Explain the motive and causes for cybercrime, detection, and handling.
3.	Investigate Areas affected by cybercrime.
4.	Illustrate tools used in cyber forensic

UNIT-I

Introduction to Cyber Security — **15 Hours**

Concepts of Cyber Security, Formal Methods of Security Validation, CIA framework-Confidentiality, Integrity and Authenticity, Threat modelling, Domains of cyber security, Security attacks, Security services, Security Mechanisms, Fundamental security design principles, Types of Cyber Threat.

UNIT-II

Tools and methods used in Cybercrime — **14 Hours**

Introduction, Proxy Servers and Anonymizers, Intruders and Hackers, Insider threats, Cybercrimes. Network Threats: Active/ Passive – Interference – Interception –Impersonation – Worms –Virus – Spam's – Ad ware - Spy ware – Trojans and covert channels –Backdoors – Bots – IP, Spoofing - ARP spoofing - Session Hijacking, Introduction to Phishing, Identity Theft (ID Theft).

UNIT-III

Understanding Computer Forensics — **11 Hours**

Introduction, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Antiforensics.

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the Cybercrime and its origin
2.	Analyse Security Threat Management and understand the security elements.
3.	Apply tools and methods used in Cyber crimes
4.	Analyse Phishing and ID Theft
5.	Comprehend Digital Forensics

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
IS2501-1.1	2	-	-	-	-	1	-	3	-	-	-	-
IS2501-1.2	-	3	-	1	-	2	-	-	2	-	-	-
IS2501-1.3	-	3	2	-	-	-	-	-	-	-	-	-
IS2501-1.4	2	-	-	-	-	2	-	-	-	-	-	-
IS2501-1.5	-	-	-	-	-	-	-	3	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education, 2006.
2. Swiderski, Frank and Syndex, "Threat Modeling", Microsoft Press, 2004.
3. Sunit Belapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt Ltd, ISBN: 978-81-265-21791, Publish Date 2013.

REFERENCE BOOKS:

1. Thomas J. Mowbray, "Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions", John Wiley & Sons, Inc, ISBN: 978 -1-118 -84965 -1, 2014.
2. James Graham, Ryan Olson, Rick Howard, "Cyber Security Essentials'', CRC Press, 15-Dec 2010. Anti- Hacker Tool Kit (Indian Edition) by Mike Shema, Publication Mc Graw-Hill.
3. Santosh B. J., K. V. S. S. S. S. Sairam, Shubham Kumar, Chandu Jagan Sekhar M, "Information and Cyber Security", Scientific International Publishing House, ISBN-978-93-5625-694-1.

PYTHON APPLICATION PROGRAMMING

Course Code:	**IS2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1002-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Construct Python programs using data types and looping.
2.	Design object-oriented Python programs using classes and objects.
3.	Design useful stand-alone and CGI applications in

UNIT-I

Functions, Classes and OOP	**15 Hours**

Functions: Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Program structure and design. Recursive functions

Classes and OOP: Classes, objects, attributes and methods; defining classes; design with classes, data modelling; persistent storage of objects, inheritance, polymorphism, operator overloading (_eq_, _str_, etc); abstract classes; exception handling, try block

UNIT-II

Lists, Tuples, and Dictionaries	**14 Hours**

Lists, tuples, and dictionaries: Basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing, and replacing values; traversing dictionaries.

File Handling: Reading From Text Files, Writing to Text Files, Working with Excel Sheets ,CSV, PDF, Word,

UNIT-III

Essential Python Libraries	**11 Hours**

Working with SciPy, Numpy, Matplotlib, Pandas.

Graphical user interfaces: event-driven programming paradigm; creating simple GUI; buttons, labels, entry fields, dialogs; widget attributes - sizes, fonts, colors layouts, nested frames Simple CGI form.

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate the basics of Python programming like data types and looping
2.	Apply the basic data structures in solving the problems
3.	Experiment with usage of functions in a given problem
4.	Develop Objects by creating classes and apply object-oriented features
5.	Develop applications in Python using File Programming &User Interface

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
IS2502-1.1	2	-	-	-	2	-	-	-	-	-	-	3
IS2502-1.2	2	-	-	-	2	-	-	-	-	-	-	3
IS2502-1.3	2	-	-	-	2	-	-	-	-	-	1	3
IS2502-1.4	-	-	-	-	-	-	-	-	-	-	-	-
IS2502-1.5	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Kenneth A. Lambert, "The Fundamentals of Python: First Programs", 2011, Cengage Learning, ISBN: 978-1111822705.

SOFTWARE ENGINEERING PRACTICES

Course Code:	**IS2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1002-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Outline software engineering principles and activities involved in building large software programs.
2.	Explain the importance of architectural decisions in designing the software.
3.	Describe the process of Agile project development.
4.	Recognize the importance of software testing and describe the intricacies involved in software evolution.
5.	Identify several project planning and estimation techniques and explain the importance of software quality.

UNIT-I

Introduction	**15 Hours**
Need for Software Engineering, Professional Software Development, Software Engineering Ethics, Case Studies.	
Software Processes	
Models: Waterfall Model, Incremental Model and Spiral Model; Process activities	
Requirements Engineering	
Functional and non-functional requirements, Requirements engineering processes, Requirements Elicitation and Analysis, Requirements specification, Software requirements document, Requirements validation & management.	

UNIT-II

System Models	**15 Hours**
Context models, Interaction models, Structural models, Behavioral models.	
T Architectural Design	
Architectural design decisions. Architectural Views and patterns, Application architectures.	
Design and implementation	
Object oriented Design using UML.	
Agile Software Development	
Agile methods, Plan-driven and agile development, Extreme Programming, Agile project management.	

UNIT-III

Project Management	**10 Hours**
Risk management, Teamwork.	

Project Planning

Software pricing, Plan-driven development, Project Scheduling.

Quality Management

Software quality, Reviews and inspections, Software measurement and metrics, Software standards.

Course Outcomes: At the end of the course student will be able to

1.	Recognise the basics of software system, component, process and Software Requirement Specification to meet desired needs within realistic constraints and outline the professional and ethical responsibility
2.	Describe the waterfall, incremental and iterative models and architectural design in implementing the software
3.	Make use of the techniques, skills, modern engineering design tools and agile methods necessary for engineering practice.
4.	Describe the methods for maintaining software system.
5.	Discuss project planning and management and illustrate the quality of software products

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
IS2503-1.1	-	3	1	-	-	-	-	2	-	-	-	-
IS2503-1.2	1	3	1	-	-	-	-	-	-	-	-	-
IS2503-1.3	1	1	3	-	-	-	-	-	-	-	-	-
IS2503-1.4	1	3	2	-	-	-	-	-	-	-	-	-
IS2503-1.5	1	2	2	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Ian Sommerville, "Software Engineering", 9th Edition, Pearson Education, 2012.

REFERENCE BOOKS:

1.	Roger S. Pressman: "Software Engineering-A Practitioners approach", 7th Edition, Tata McGraw Hill, 2017.
2.	Pankaj Jalote: "An Integrated Approach to Software Engineering", Wiley, India, 2010.

E Books / MOOCs/ NPTEL

1.	http://agilemanifesto.org/
2.	http://www.jamesshore.com/Agile-Book/
3.	https://www.mooc-list.com/course/uml-class-diagrams-software-engineering-edx
4.	https://www.mooc-list.com/course/enterprise-software-lifecycle-management-edx

WEB TECHNOLOGIES

Course Code:	**IS2504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1002-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Illustrate the Semantic Structure of HTML and CSS
2.	Compose forms and tables using HTML and CSS
3.	Design Client-Side programs using JavaScript and Server-Side programs using PHP
4.	Illustrate the Database connectivity using PHP
5.	Examine JavaScript frameworks such as jQuery

UNIT-I

Introduction to HTML	**15 Hours**

HTML tags and simple HTML forms, web site structure, HTML table, Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colours and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, Selectors, The Cascade: How Styles Interact, The Box Model, CSS Text Styling.

UNIT-II

Client side Scripting	**15 Hours**

Introduction to JavaScript: JavaScript language – declaring variables, scope of variables functions, event handlers (on click, on submit etc.), Document Object Model, Form validations. Introduction to PHP: Declaring variables, data types, arrays, strings, operations, expressions, control structures, functions, Reading data from web form controls like Text Boxes, radio buttons, lists etc.,

UNIT-III

PHP Databases	**10 Hours**

Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, File Handling in PHP, PHP Arrays and Superglobals, Arrays, $_GET and $_POST Superglobal Arrays, jQuery Introduction: What is jQuery, Adding jQuery in to your web pages, jQuery Syntax, jQuery Selectors, jQuery Events.

Course Outcomes: At the end of the course student will be able to

1.	Adapt HTML and CSS syntax and semantics to build web pages
2.	Construct and visually format tables and forms using HTML and CSS.

3.	Experiment with the usage of Event handling and Form validation using JavaScript.
4.	Understand the principles of object-oriented development using PHP and Database concepts.
5.	Inspect JavaScript frameworks like jQuery which facilitates developers to focus on core features.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
IS2504-1.1	1	2	-	2	-	-	-	-	-	-	-	1
IS2504-1.2	1	-	-	2	-	-	-	-	-	-	-	1
IS2504-1.3	1	2	-	2	3	-	-	-	-	-	-	1
IS2504-1.4	1	2	-	2	3	-	-	-	-	-	-	1
IS2504-1.5	1	-	-	2	3	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", 1st Edition, Pearson Education India. (ISBN:978-9332575271).

E Books / MOOCs/ NPTEL

1.	nptel.ac.in/courses/106105084/11

GRAPH THEORY

Course Code:	**MA1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	Explain subgraphs, bipartite graphs, isomorphic graphs etc. Apply the concept of trees and its properties
2.	Distinguish between Hamilton and Eulerian graph. Distinguish between planar and nonplanar graphs and apply their properties to solve problems.
3.	Represent a graph in terms of adjacency matrix, incidence matrix etc. and vice-versa.
4.	Find the shortest path between two vertices in a graph. Find minimal spanning tree.

UNIT-I

Introduction to graphs	**15 Hours**
Graphs and Graph Models, digraphs, Konigsberg bridge problem. Special Types of Graphs: Subgraphs-spanning and induced subgraphs, complete graph, Bipartite Graphs. Isomorphism of graphs. Complement of a graph and its properties. Connectivity-point and line connectivity. Trees and its properties. Euler and Hamilton graphs and their applications.	

UNIT-II

Planar graphs	**09 Hours**
Euler's polyhedron formula, outer planar graphs, applications	
Colorability	**07 Hours**
Chromatic number, five color theorem, chromatic polynomial, Applications of graph coloring.	
Matrix representation of graphs	
Adjacency matrix, incidence matrix, circuit matrix, cut set matrix, Path matrix.	

UNIT-III

Network Flows	**04 Hours**
Max -flow and Min-cut Theorem(statement), problems.	
Shortest paths in weighted graphs	
Dijkstra's algorithm to find shortest paths.	
Spanning trees	**05 Hours**
Algorithms to find a spanning tree, minimal spanning tree-Kruskal's & Prim's algorithm.	

Course Outcomes: At the end of the course student will be able to

1.	Distinguish between bipartite and complete bipartite graphs, identify whether two graphs are isomorphic, find subgraphs of a graph etc.
2.	Distinguish between Eulerian and Hamiltonian graphs.
3.	Identify whether a graph is planar and to find the chromatic polynomial of a graph.
4.	Representing graphs interms of Matrices.

5.	Apply algorithmic methods to find the shortest path between two given vertices. Use a suitable algorithm to find a minimal spanning tree.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MA1501-1.1	3	3	-	-	-	-	-	-	-	-	-	-
MA1501-1.2	2	1	-	-	-	-	-	-	-	-	-	-
MA1501-1.3	2	3	-	-	-	-	-	-	-	-	-	-
MA1501-1.4	3	2	-	-	-	-	-	-	-	-	-	-
MA1501-1.5	3	2	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. F. Harary, “Graph theory”, Narosa Publishing House, 1988.

2. Narsing Deo, “Graph Theory with applications to Engg. and Comp. Sciences”, PHI,1974.

3. Kenneth H. Rosen, “Discrete Mathematics and its applications”, Tata McGraw Hill, VEdition-2003.

REFERENCE BOOKS:

1. D. B. West, “Introduction to Graph Theory”, PHI,2001.

2. Chartrand and Zhang, “First Course in Graph Theory”, 2012

E Books / MOOCs/ NPTEL

1. http://diestel-graph-theory.com.

2. https://nptel.ac.in/courses/111106102

NUMBER THEORY

Course Code:	**MA1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	Understand the divisibility of integers, study of prime numbers and basic properties of congruences.
2.	Study Fermat's little theorem and understand Euler's function.
3.	Study the existence of primitive roots and quadratic residues.
4.	Study the cryptographic applications in number theory.

UNIT-I

Divisibility and the theory of congruences	**15 Hours**

Division algorithm, Euclid's algorithm for the greatest common divisor. Linear Diophantine equations. Prime numbers, fundamental theorem of arithmetic. Basic properties of congruences, Linear congruences and Chinese reminder theorem.

UNIT-II

	07 Hours

Fermat's theorem, Wilson's theorem, Euler's Phi function, Euler's theorem.

Primitive roots and Quadratic congruences	**08 Hours**

Order of an integer modulo n, primitive roots for primes, Euler's criterion, Legendre symbol and its properties.

UNIT-III

Cryptography	**10 Hours**

Introduction to public key cryptography, RSA cryptosystem, an application of primitive roots to cryptography.

Course Outcomes: At the end of the course student will be able to

1.	Use divisibility and Greatest common divisor in Euclidean algorithm. Solve Diophantine equations. Identify prime factorization of an integers.
2.	Understand the properties of congruences. Use Chinese reminder theorem to find solution of system of linear congruences
3.	Use Fermat's Little Theorem and Wilson's Theorem. Use of Euler's Phi function.
4.	Identify primitive roots of an integers. Apply Euler's criterion and Legendre symbols.
5.	Code and decode numbers in the RSA cryptosystem.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
MA1502-1.1	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.2	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.3	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.4	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.5	2	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	D. Burton, "Elementary Number Theory", McGraw-Hill, 2005.
2.	Niven, H.S. Zuckerman & H.L. Montgomery, "Introduction to the Theory of Numbers", Wiley, 2000.

REFERENCE BOOKS:

1.	H. Davenport, "The Higher Arithmetic", Cambridge University Press, 2008.
2.	G. A. Jones & J. M. Jones, "Elementary Number Theory", Springer UTM, 2007.
3.	Thomas Koshy, "Elementary Number Theory with Applications", 2nd edition, Elsevier, 2007.
4.	William J. LeVeque, "Fundamentals of Number Theory".

E Books / MOOCs/ NPTEL

1.	http://refkol.ro/matek/mathbooks/ro.math.wikia.com%2520wiki%2520Fisiere pdf_incarcate/ Elementary-Number-Theory.pdf
2.	https://nptel.ac.in/courses/111104138
3.	https://nptel.ac.in/courses/111103020

LINEAR ALGEBRA

Course Code:	**MA3501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA1001-1 and MA2009-1**		

Teaching Department: Mathematics

Course Objectives:

1.	Understand the concepts of vectors, bases.
2.	Determine the kernel, range, rank, and nullity of a linear transformation and apply them suitably in their field of study.
3.	Find the canonical forms and appraise its importance in various fields.
4.	Make use of Gram-Schmidt process to produce an orthonormal basis.
5.	Learn the concepts of singular value decomposition and PCA.

UNIT-I

Vector spaces	**08 Hours**
Vector spaces, subspaces, bases and dimensions, coordinate vecotrs, null spaces and column spaces of the matrices.	
Linear Transformations	**07 Hours**
Linear transformations, rank-nullity theorem, algebra of linear transformations, change of basis, linear operators, linear functionals, transpose of a linear transformation.	

UNIT-II

Canonical Forms	**08 Hours**
Review of characteristic values, similarity of matrices, Cayley Hamilton theorem, annihilating polynomials, invariant subspaces, Jordan and rational canonical forms.	
Inner Product Spaces	**07 Hours**
Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt process; QR-factorization, Least-squares problems.	

UNIT-III

Symmetric Matrices and Quadratic Forms	**10 Hours**
Diagonalization, quadratic forms, constrained optimization, singular value decomposition and principal component analysis. Applications to linear recurrence relations.	

Course Outcomes: At the end of the course student will be able to

1.	Interpret vectors in two and three-dimensional spaces both algebraically and geometrically.
2.	Analyze the concept of a linear transformation as a mapping from one vector space to another and be able to calculate its matrix representation with respect to standard and nonstandard bases.
3.	Understand the concepts of Jordan and rational canonical forms.

4.	Make use of Gram-Schmidt process to produce an orthonormal basis and also able to use least square approximation method to obtain the solution of ill conditioned system.
5.	Apply techniques of constrained optimization singular value decomposition and PCA for problems arising in various engineering fields.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MA3501-1.1	3	2	-	-	-	-	-	-	-	-	-	-
MA3501-1.2	2	2	-	-	-	-	-	-	-	-	-	-
MA3501-1.3	3	1	-	-	-	-	-	-	-	-	-	-
MA3501-1.4	3	2	-	-	-	-	-	-	-	-	-	-
MA3501-1.5	3	2	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kenneth Hoffman and Ray Kunze, "Linear Algebra," 2nd edition, Pearson Education (Asia) Pte. Ltd, 2004.
2.	David C. Lay, "Linear Algebra and its Applications",3rd edition, Pearson Education (Asia) Pte. Ltd, 2005.

REFERENCE BOOKS:

1.	M. Artin, "Algebra", Prentice Hall of India, 2004.
2.	Gilbert Strang, "Linear Algebra and its Applications", 4th edition, Thomson Learning Asia, 2003.
3.	Bernard Kolman and David R. Hill, "Introductory Linear Algebra with Applications", Pearson Education (Asia) Pte.Ltd, 7th edition ,2003.
4.	Sheldon Axler, "Linear Algebra Done Right", Springer International Publication, Third Edition, 2015.

AUTOMOTIVE ENGINEERING

Course Code:	**ME1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Get an idea on the different components of an engine and its types with lubrication system.
2.	Understand the fuel supply system and ignition systems used in automobiles.
3.	Demonstrate the working of transmission system.
4.	Explain the importance of suspension system, steering geometry and drives in automobiles
5.	Know the concept of braking system, tyres and emission control.

UNIT-I

Engine Components and Cooling & Lubrication Systems	**08 Hours**

SI & CI engines, Cylinder arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Choice of materials for different engine co mponents, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements, crankshaft/flywheel position sensor, accelerator pedal sensors, engine coolant water temperature sensor.

Fuel Supply Systems for SI and CI Engines	**08 Hours**

Fuel mixture requirements for SI engines, types of carburetors, si mple carburetor, multi point and single point fuel injection systems, CRDI, fuel transfer pumps: AC Mechanical Pump, SU Electrical Pumps, injectors, Fuel gauge sensor, Throttle position sensor, Mass air flow sensors.

Ignition Systems : Battery Ignition systems, magneto Ignition system, Transistor assisted contacts. Electronic Ignition, Automatic Ignition advance systems, Lighting systems, Rain/Light sensors, starting device (Bendix drive)

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

Power Trains	**07 Hours**

Clutches - Single plate, multiplate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission, Constant m esh gear box, Synchromesh gear box, principle of automatic transmission, Vehicle Speed Sensors, calculation of gear ratios, Types of transmission systems. No numerical.

Drive to Wheels	**08 Hours**

Propeller shaft, universal joints, Hotchkiss. and torque tube drives, differential, rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out,

condition for exact steering, power steering, over steer, under steer & neutral steer, Steering angle sensors, numerical problems.
Suspension and Springs: Requirements, leaf spring, coil spring, Torsion bar suspension systems, independent suspension for front Wheel, Air suspension system. Collective bargaining; Characteristics, Necessity, Forms Safety & Health; Industrial accidents, Safety Quality circle; Meaning, Structure
Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

Brakes	**09 Hours**

Types of brakes, mechanical, compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, Drum brakes.
Tyres: Desirable tyre properties, Types of tyres.
Automotive Emission: Automotive exhaust emissions, sources and emission control method: EGR, SCR, Emission Standards, Exhaust sensors.
Electric Vehicles.
Pedagogy Chalk and talk method, Power Point Presentation

Course Outcomes: At the end of the course student will be able to

1.	Describe and demonstrate the layout of an automobile and components of an automobile engine. Explain cooling and lubrication systems.
2.	Explain and demonstrate the fuel supply and Ignition systems for SI and CI engines.
3.	Describe and demonstrate the transmission system
4.	Explain and demonstrate the components of drive to wheel and suspension system, calculate the parameters of steering geometry.
5.	Describe and demonstrate automotive braking system. Explain types and construction of tyres and wheels. Explain the significance of automotive emissions and its controlling methods

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1501-1.1	3	1	-	-	-	1	-	-	3	1	-	1
ME1501-1.2	3	1	-	-	-	1	-	-	3	1	-	1
ME1501-1.3	3	1	1	-	-	1	-	-	3	1	-	1
ME1501-1.4	2	3	1	-	-	1	-	-	3	1	-	1
ME1501-1.5	3	1	1	-	-	1	1	1	3	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. S. Srinivasan, "Automotive Mechanics", Tata McGraw Hill, 2003.

2.	Kirpal Singh, "Automobile Engineering", Vol I and II, 2013.
3.	A. K. Babu, "Automotive Electrical and Electronics", Khanna Publishers, 2nd edition, 2016.
REFERENCE BOOKS:	
1.	R. B. Gupta, "Automobile Engineering", Satya Prakashan, 4th Edn., 1984 .
2.	Naran G, "Automobile Engineering", Khanna Publishers 2002

INDUSTRIAL POLLUTION CONTROL

Course Code:	**ME1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Know the Consequences of pollution, relationship between man and environment over the last few decades, necessity of modern awareness on pollution and how carbon audit can help in developing a carbon strategy.
2.	Identify the Importance of Meteorology in pollution control and global warming, various types of plume dispersions and its effect; analyze various levels of plume height for different pollutants.
3.	Distinguish Particulates and fly ash separation techniques such as cyclone separator, electrostatic precipitator efficiency calculations etc.
4.	Illustrate Formation, measurement and control techniques for Smoke and gaseous pollutants.
5.	Summarize the Effects of water, soil, plastics and odor pollution their control techniques, Different Pollution Control Acts, Legal aspects of pollution control and how these acts can help in bringing down the pollution rate.

UNIT-I

Introduction to Pollution	**08 Hours**

Man and the environment, types of pollution and its consequences, Changing environmental management concept, sustainable industrial growth, carbon audit, Ill effects of various pollutants, permissible concentration levels & AQI.

Meteorology	**08 Hours**

Meteorology, Wind rose, Lapse rate, plume dispersion studies & Numerical problems.
Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

Separation techniques	**08 Hours**

Different types of Particulates, Need for Separation techniques, Sources of Particulates Matter Fly Ash Electrostatic precipitator (Problems) Theory of settling processes (Design Problems), Bag House fabric filter Cyclone separator Spray Tower Scrubbers & Venturi Scrubber

Smoke and gaseous pollutants:	**08 Hours**

Smoke- White, blue and black smoke, Sources of smoke, T,T,T-O Principle of smoke Measurement of stack smoke intensity using Ringlemann Chart and Smokescope &Bosch Smoke meter, Domestic and Industrial Incinerators-Design factors, Pollutant gaseous So2, Co, UBHC, Nox their ill effects and & control methods.

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

08 Hours

Water, soil, noise, and odor pollution, their control methods, problems associated with nuclear reactors, Legal aspects of pollution control in India, brief details of Euro and BS standards

Pedagogy: Chalk and talk method, Power Point Presentation

Course Outcomes: At the end of the course student will be able to

1.	Identify the various types of pollutants and distinguish between them with regards to Particulate matters and AQI.
2.	Outline the instruments for Meteorological measurements, distinguish types of plume dispersions and its effect; analyze the concentration of various gaseous pollutants from T-Z diagrams
3.	Explain the Particulates and fly ash separation techniques, compare and Interpret their efficiency
4.	Illustrate Formation, measurement and control techniques for Smoke and gaseous pollutants
5.	Identify Effects of water, soil, plastics and odor pollution on environmental Pollution and explain the Legal aspects of pollution control.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1502-1.1	1	-	-	1	-	3	3	2	1	2	-	3
ME1502-1.2	1	2	1	1	3	2	3	1	1	1	-	2
ME1502-1.3	1	2	2	1	1	2	3	1	1	1	-	1
ME1502-1.4	1	1	1	1	1	2	3	1	1	1	-	2
ME1502-1.5	1	-	-	1	-	2	3	1	1	1	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	"Environmental Pollution Control Engineering", Wiley Eastern Ltd.,
2.	Gilbert M Masters, "Introduction to Environmental Engineering & Science", PHI,1995
3.	C. S Rao, "Environmental Pollution Control Engineering", New Age Int.

REFERENCE BOOKS:

1.	Henry C. Perkins, "Air Pollution", Mc-Graw Hill, 1974.
2.	W. L. Faith, "Air Pollution control", John Wiley

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/105106119/36

SUSTAINABLE DEVELOPMENT GOALS

Course Code:	**ME1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To provide the knowledge, skills, attitudes and values necessary to address sustainable development challenges
2.	Address the global challenges including poverty, inequality, climate change, environmental degradation, peace and justice.
3.	To learn more and take action.
4.	Addresses critical global challenges put forth by UN.
5.	Analyze how sustainable development can be achieved in practice.

UNIT-I

08 Hours

The origin, development and idea of the SDGs History and origins of the Sustainable Development Goals. What are the SDGs? What are their aims, methodology and perspectives? How are they related to the Millennium Development Goals?

SDGs and Society — **08 Hours**

Ensuring resilience and primary needs in society In-depth discussion and analysis of goals related to poverty, hunger, health & well-being and education

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

SDGs and Society — **14 Hours**

Strengthening Institutions for Sustainability In-depth discussion and analysis of goals related to gender equality, affordable and clean energy, sustainable cities & communities, and peace, justice & strong institutions

SDGs and the Economy: Shaping a Sustainable Economy In-depth discussion and analysis of goals related to work & economic growth, industry, innovation & infrastructure, inequalities, responsible production & consumption

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

SDGs and the Biosphere — **10 Hours**

Development within Planetary Boundaries In-depth discussion and analysis of goals related to clean water, climate, life below water and life on land

Realizing the SDGs: Implementation through Global Partnerships In-depth discussion and analysis of SDG 17 which aims to implement the SDGs through partnerships, finance, technology and the development of coherence between policies.

Pedagogy: Chalk and talk method, Power Point Presentation

Course Outcomes: At the end of the course student will be able to

1.	Summarize the UN‟s Sustainable Development Goals and how their aims, methodology and perspectives.
2.	Analyze the major issues affecting sustainable development and how sustainable development can be achieved in practice.
3.	Identify and apply methods for assessing the achievement/possibilities of sustainable development in Nitte gram panchayath.
4.	Evaluate the implications of overuse of resources, population growth and economic growth. sustainability & Explore the challenges the society faces in making transition to renewable resource use.
5.	Create skills that will enable students to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1503-1.1	1	2	1	1	1	3	3	1	1	1	-	2
ME1503-1.2	2	2	1	1	1	3	3	2	1	1	-	1
ME1503-1.3	3	2	2	1	1	3	3	2	3	1	-	1
ME1503-1.4	3	2	3	1	1	3	3	2	1	1	-	1
ME1503-1.5	1	2	2	1	1	3	3	2	2	2	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Sachs, Jeffrey D. "The age of sustainable development" Columbia University Press, 2015
2.	Gagnon, B., Leduc, R., and Savard, L., "Sustainable development in engineering: a review of principles and definition of a conceptual framework", Cahier de recherche / Working Paper 08-18, 2008.

REFERENCE BOOKS:

1.	Elliott, Jennifer, "An introduction to sustainable development", Routledge, 2012.

E Books / MOOCs/ NPTEL

1.	https://www.un.org/sustainabledevelopment/poverty/

TECHNOLOGY INNOVATION

Course Code:	**ME1504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Understand basics of operations management and Quality.
2.	Define the concept of technological innovation.
3.	Discuss Innovation management and the difference between Invention and Innovation.
4.	Appreciate the importance of Innovation as a management process and Innovation management techniques.
5.	Discuss the Innovation system, Understand the importance of Technology management and Transfer and basics of Technological Forecasting.

UNIT-I

Production and Operations Management and Introduction to Quality Concepts — **04 Hours**

Production and Operations Management: Introduction - Functions within business organizations - the operation management function - Classification of production systems.
Introduction to Quality Concepts: The Meaning of Quality and Quality Improvement - Key dimensions of Quality - Concept of cost of quality - Customers' perception of quality.

Introduction to Technological Innovation — **09 Hours**

Basic Concepts and Definitions: Technology - Technology Management – Invention – Creativity – Innovation - The Concept of Technological Innovation - Innovation Posture, Propensity and Performance - Innovation Measurement - Key factors linking creativity and innovation – Classifications of Innovations – Innovation Process.

Startup Idea Pitching — **03 Hours**

UNIT-II

Introduction to Innovation Management and Innovation & Competitiveness — **07 Hours**

Introduction to Innovation Management: Innovation Management Through Management of Knowledge and Education – Types of Learning - Difference Between Innovation and Invention - Types and Characteristics of Innovation.
Innovation and Competitiveness: Case Study – Barriers for Innovation and Competitiveness

Innovation as a Management Process — **08 Hours**

Activities to enhance companies' capacity for innovation – Management of Technological Innovation: Corporate Perspective, National Perspective, Theoretical Perspective and Individual Perspective - Challenges in Technological Innovation Management - Case Study in Technological Innovation Management - Innovation Management Techniques (IMTs).

UNIT-III

Innovation Systems and Technology Management & Transfer — **04 Hours**

Innovation Systems: The Concept of Innovation Systems - Innovation Systems: Sectoral, Regional, National.
Technology Management and Transfer: Technology Transfer - Impacts of MNCs in technology transfer

Introduction to Technological Forecasting — **05 Hours**

Introduction - Applications & Limitations of Technological Forecasting – Technology Forecasting Techniques – Exploratory Forecasting – Normative Forecasting – Delphi Technique – Problems of Technological Forecasting

Course Outcomes: At the end of the course student will be able to

1.	Define operations management and quality.
2.	Describe technological innovation and its key features for business.
3.	Discuss innovation management and the difference between invention and innovation.
4.	Explain innovation as a management process, its management and perspectives. Understand Innovation management techniques.
5.	Explain innovation systems, technology management transfer and basics of technological forecasting.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1504-1.1	3	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.2	3	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.3	2	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.4	2	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.5	3	2	-	-	-	1	1	-	1	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Carayannis, Elias G., Samara, Elpida T., Bakouros, Yannis L., "Innovation and Entrepreneurship Theory, Policy and Practice", Springer, 2015.

REFERENCE BOOKS:

1. Dick Whittington, "Digital Innovation and Entrepreneurship", Cambridge University Press, 2018.

E Books / MOOCs/ NPTEL

1. https://krishi.icar.gov.in/jspui/bitstream/123456789/46063/1/21_Technological%20forecasting.pdf dtd 12/06/2022
2. http://www.oipec.eu/wp-content/uploads/2017/07/Introduction-to-Technology-Forecasting.pdf dtd 12/06/2022

HUMAN RESOURCE MANAGEMENT

Course Code:	**MG1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To develop a meaningful understanding of HRM theory, functions and practices.
2.	To understand concepts and skills recruitment.
3.	To understand the concepts of training and development.
4.	To deal with employees' grievances, safety and health types of organizations.
5.	To understand the concepts of e-HRM.

UNIT-I

Human Resource Management & HRP	**08 Hours**

Introduction, meaning, nature, scope of HRM. Major functions of HRM, Personnel Management vs Human Resource Management, job design, job evaluation, job analysis, job specification, job enlargement, job enrichment. Role of HR Manager.HR Planning. Process HRP.

Recruitment	**08 Hours**

Definition, Sources and Methods of Recruitment Selection: Definition and Process of Selection. Cost benefit analysis of selection.

Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation. Performance Appraisal methods.

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

Training and development	**07 Hours**

Training v/s development, stages in training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.

Compensation	**08 Hours**

Employee remuneration, rewards, Wage and Salary Administration, Bonus, fringe benefits. Internal Mobility, External Mobility, Trade union Act (Amendment) 2001.

Employee Grievances: Employee Grievance procedure. Discipline procedure

Collective bargaining; Characteristics, Necessity, Forms Safety & Health; Industrial accidents, Safety Quality circle; Meaning, Structure

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

IHRM and e-HRM	**09 Hours**

Managing IHRM. e-HR Activities, Global recruitment, selection, expatriates. Industrial conflict –Causes, Types, Prevention and Settlement.

Aspects of e-HRM,e-Job design & Analysis, Ethical issues in employment

Pedagogy: Chalk and talk method, Power Point Presentation

Course Outcomes: At the end of the course student will be able to

1.	Describe the basic concepts of HRM & HRP.
2.	Elucidate the HRM functions of recruitment, selections, and appraisal.
3.	Apply the training, development and compensation methods in HRD.
4.	Identify the employee grievances to spell out the remedial measures.
5.	Infer the concepts of e-HRM and I-HRM.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1501-1-1.1	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.2	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.3	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.4	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.5	3	-	-	-	-	1	-	-	1	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. P Courseba Rao, "Essentials of Human Resource Management & Industrial Relations", Third Revised Edition.

REFERENCE BOOKS:

1. John M. Ivancevich, "Human Resource Management", 10/e, McGraw Hill.
2. Flippo, "Human Resource Management".

E Books / MOOCs/ NPTEL

1. http://edx.nimt.ac.in/courses/course-v1:nimtX+PGDM1212+2017_H1/about

MANAGEMENT ACCOUNTING AND CONTROL SYSTEM

Course Code:	**MG1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	Apply Cost Accounting concepts and techniques in the decision making process.
2.	Make decisions such as pricing, special order pricing, make-or-buy and elimination of a part of the company or replacement of equipment.
3.	Understand the relevance of different types of costs in the decision making process such as relevant costs, sunk costs or controllable costs.
4.	Understand fundamental concepts in Financial, Cost & Management Accounting.
5.	Develop analytical skills associated with the preparation and interpretation of Financial Statement

UNIT-I

Introduction to Cost and Management Accounting and Marginal Costing	**07 Hours**

Cost Accounting – Meaning, Objectives and Scope, Management Accounting – Meaning, Objectives and Scope, Tools and Techniques of Management Accounting, Relationship of Cost Accounting, Financial Accounting, Management Accounting and Financial Management, Conflicts in Profit versus Value Maximization Principle, Role of Management Accountant in Decision Making.

Marginal Costing	**08 Hours**

Meaning, Advantages, Limitations and Applications. Breakeven Analysis, Cost Volume Profit Analysis, P/V Ratio and its Significance, Margin of Safety, Absorption Costing: System of Profit Reporting and Stock Valuation, Difference between Marginal Costing and Absorption Costing, Income Measurement under Marginal Costing and Absorption Costing. (Practical Problems)

UNIT II

Standard Costing and Budgetary Control	**07 Hours**

Standard Costing – Definition, Significance and Applications, Various Types of Standards, Installation of Standard Costing System-for Material, Labour, and Overhead. Variance Analysis for Materials, Labour and Overheads, Accounting Treatment of Variances. Benchmarking for Setting of Standards, Variance Reporting to Management. (Practical Problems)

Budgetary Control	**08 Hours**

Budget Concept, Manual, Fixed and Flexible Budgets, Preparation and Monitoring of Various Types of Budgets, Budgetary Control System- Advantages, Limitations and Installation. Zero Base Budgeting, Programme and Performance Budgeting. (Practical Problems)

UNIT III

Fund Flow and Cash Flow Statement	**05 Hours**
Fund Flow Statement Analysis – Definition, Features, Steps for Preparation of Fund Flow Statement.	
Cash Flow Statement Analysis	**05 Hours**
Classification, Preparation of Cash Flow Statement, Uses of Cash Flow statement, Difference between Cash Flow and Fund Flow Statement. (Practical Problems)	

Course Outcomes: At the end of the course student will be able to

1.	Describe the Cost Accounting concepts and techniques in the decision making process.
2.	Elucidate the Make decisions such as pricing, special order pricing, make-or-buy and elimination of a part of the company or replacement of equipment.
3.	Apply the relevance of different types of costs in the decision making process such as relevant costs, sunk costs or controllable costs.
4.	Identify fundamental concepts in Financial, Cost & Management Accounting.
5.	Infer the analytical skills associated with the preparation and interpretation of Financial Statement

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1502-1-1.1	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.2	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.3	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.4	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.5	3	-	-	-	-	1	-	-	1	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. M.Y. Khan and P.K. Jain. “Management Accounting”, McGraw-Hill Education
2. Robert N. Anthony, “Management Accounting”, Richard Dirwin.
3. I.M. Pandey , “Management Accounting”, Vikas Publishing House.
4. Paresh shaw, “Management Accounting”, Oxford University Press.
5. A. Murthy and S. Gurusamy , “Management Accounting”, McGraw Hill.
6. NM Singhvi and Ruzbeh J. Bodhanwala, “Management Accounting”, PHI learning Pvt. Ltd.

OPERATIONS AND QUALITY MANAGEMENT

Course Code:	**MG1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	Define production/operations management. Differentiate between Production and service system and types of production systems Discuss continuous and intermittent production systems with their advantages and disadvantages. Discuss CRM and ERP systems.
2.	Solve problems on fundamentals of statistics and normal distribution. Draw and Analyze variable process control charts and determine process capability.
3.	Discuss Total Quality Management tools and methods. Calculate reliability of series and parallel systems using the information on failure rate and time.
4.	Solve decision-making problems using break even analysis and decision tree methods. Apply the concepts of Design and System capacity. Solve problems on faculty location using break even analysis and transportation method. Solve problems related to product and process layouts.
5.	Use concepts of replacement theory to solve problems of replacing items that fail gradually and suddenly.

11.

12.

UNIT-I

Production and Operations Management — **06 Hours**

Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity, Introduction to Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP).

Philosophy of statistical process control and modeling process quality — **11 Hours**

Normal distribution tables, Finding the Z score, Central limit theorem, Chance and assignable causes of variation, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, warning limits)

Control charts for variables: Control Charts for X-Bar and R- Charts, Type I and Type II errors, Simple Numerical Problems,

Process capability: The foundation of process capability, Natural Tolerance limits, c_p – process capability index, c_{pk}, p_p – process performance index, summary of process measures. Numerical problems. Concept of Six sigma.

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT II

Quality Concepts and Reliability — **06 Hours**

Introduction to Quality Concepts: The Meaning of Quality and Quality Improvement, Key dimensions of Quality, Concept of cost of quality. Customers' perception of quality.

TOTAL Quality Management: Definition, Principles of TQM, Gurus of TQM, Benefits of TQM.

Managing Quality: Quality circles, Continuous Improvement- Juran's Trilogy, PDSA cycle, Kaizen, 7 QC tools.
Introduction to reliability, Mean time to failure, Mean time between failures, Bath tub curve, Reliability of series and parallel systems, Numerical problems on the above topics.

Operations Management activities	**12 Hours**

Decision Making: The decision process, characteristics of operations decisions, use of models - decision making environments. Break even Analysis, Decision trees.
Capacity Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity. Design, System an actual capacity. System efficiency and utilization. Determination of Equipment requirement for a single stage production processes. Numerical problems on the above.
Facilities location planning: Need for location decisions, nature of locations decisions, general procedure for making locations decisions, Use of Breakeven analysis and Transportation algorithms for making location decisions.
Facilities layout planning: Need for layout decisions. Minimizing material handling cost in process ayout using Load distance analysis, Simple line balancing problems in product layout.

UNIT III

Replacement Theory	**05 Hours**

Replacement policy for equipment which deteriorates gradually. Replacement of items that fail suddenly.
Pedagogy: Chalk and talk method, Power Point

Course Outcomes: At the end of the course student will be able to

1.	Define production/operations management. Differentiate between Production and service system and types of production systems Discuss continuous and intermittent production systems with their advantages and disadvantages. Discuss CRM and ERP systems.
2.	Solve problems on fundamentals of statistics and normal distribution. Draw and Analyze variable process control charts and determine process capability.
3.	Discuss Total Quality Management tools and methods. Calculate reliability of series and parallel systems using the information on failure rate and time.
4.	Solve decision-making problems using break even analysis and decision tree methods. Apply the concepts of Design and System capacity. Solve problems on faculty location using break even analysis and transportation method. Solve problems related to product and process layouts.
5.	Use concepts of replacement theory to solve problems of replacing items that fail gradually and suddenly.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1503-1-1.1	2	1	-	-	-	-	-	-	-	-	2	-
MG1503-1-1.2	2	2	-	-	-	-	-	-	-	-	2	-
MG1503-1-1.3	1	1	-	-	-	-	-	-	-	-	2	-

MG1503-1-1.4	3	2	-	-	-	-	-	-	-	-	3	-
MG1503-1-1.5	1	1	-	-	-	-	-	-	-	-	1	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Joseph G Monks, "Production / Operations Management", McGraw Hill Books
2.	William J Stevenson, "Production and Operations Management", Tata McGraw Hill, 8th Edition.
3.	RC Gupta, "Statistical Quality Control", Khanna Publishers, New Delhi, 2005.
4.	N.D. Vohra, "Quantitative Techniques in Management", Tata McGraw Hill, 2015

REFERENCE BOOKS:

1.	E.L. Grant and R.S. Leavenworth, **"Statistical Quality Control",** 7th edition, McGraw-Hill publisher, 2004.
2.	Prem Kumar Gupta, D S. Hira, "Operations Research", S Chand Publications, New Delhi, 2nd edition 2008, Prentice Hall.
3.	W S Messina**, "Statistical Quality Control for Manufacturing Managers",** Wiley & Sons, Inc. New York, 1987
4.	Montgomery, Douglas, "**Statistical Quality Control",** 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ.
5.	Jerry Banks, "**Principles of Quality Control",** Wiley & Sons, Inc. New York.

ORGANIZATIONAL BEHAVIOUR

Course Code:	**MG1504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	Describe the Nature and Characteristics, Determinants and Approaches of Organizational Behaviour. Describe the concepts of Perception, Attitudes and values and their implications.
2.	Describe the concepts of learning and motivation along with their managerial implications.
3.	Describe the concepts of Leadership along with their managerial implications.
4.	Discuss the concepts of group dynamics and conflict management along with their implications.
5.	Discuss the concepts of Organization culture and change and conflict management along with their implications.

13.

UNIT-I

15 Hours

Introduction: Conceptual Foundation of Organisational Behaviour; Nature and Characteristics; Determinants; Contributing Disciplines; Challenges and Opportunities for Organisational Behaviour, Models and Approaches of Organizational Behaviour, OB and Emotional Intelligence.

Perception, Attitude, and Values: Nature, Process, Importance, Factors Influencing Perception; Attribution Theory of Perception; Issues Involved in Perception: Selective Perception, Halo Effect, Contrast Effect, Projection, Stereotyping; Concept of Pygmalion Effect; an overview of Emotions and feelings, Values, Beliefs and Attitudes with Managerial Implications.

Learning: Concept; Theories of Learning: Conditioning, Social Learning, Managerial Implication of Learning Theories. Reinforcement.

Motivation: Concept, Major Theories and Process of Motivation: Maslow's Need-Hierarchy Theory; Herzberg's Motivation-Hygiene Theory; McGregor's Theory X and Theory Y; Goal-Setting Theory; ERG Theory; Vroom's Expectancy Theory; Equity Theory; Managerial implications of Various Theories.

Pedagogy: Chalk and talk method, Power Point Presentation, Case studies

UNIT II

15 Hours

Leadership: Concept and Functions; Style and Theories of Leadership: Traits, Behavioural and Situational/ Contingency Groups of Theories; Inspirational approaches to Leadership; Charismatic Leadership, Transformational Leadership, and Transactional Leadership, Contemporary Leadership Roles; Challenges to the Leadership Construct; Substitutes and Neutralizers to Leadership.

Group Behaviour: Groups: Concept and Classification; Stages of Group Development; Group Structure; Roles and Norms; Premise and Issues; Group Decision-Making: Group vs

Individual;
Groupthink and Groups Shift; Group Decision Making Techniques and Process.
Conflict Management: Concept; Causes; Types; Stages; Effects; Management of Conflicts.
Pedagogy: Chalk and talk method, Power Point Presentation, Case studies

UNIT III

10 Hours

Organizational Culture: Concept; Dominant Culture; Strong vs Weak Cultures ; Creating and Sustaining Culture; Employees Learning of The Culture; Creating a Customer-Responsive Culture.
Organizational Changes: Concept and Forces for Change; Managing Planned Changes; Resistance to Change; Approaches to Manage Organizational Change; Organizational Development;
Culture-Boundedness of Managing the Change.
Pedagogy: Chalk and talk method, Power Point Presentation, Case studies

Course Outcomes: At the end of the course student will be able to

1.	Describe the Nature and Characteristics, Determinants and Approaches of Organizational Behaviour. Describe the concepts of Perception, Attitudes and values and their implications.
2.	Describe the concepts of learning and motivation along with their managerial implications.
3.	Describe the concepts of Leadership along with their managerial implications.
4.	Discuss the concepts of group dynamics and conflict management along with their implications.
5.	Discuss the concepts of Organization culture and change and conflict management along with their implications.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1504-1-1.1	2	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.2	2	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.3	1	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.4	3	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.5	1	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Robbins, SP Stephen P, Timothy Judge and Nehasika Vohra, "Organisational Behaviour", 12th or 16th edition, Pearson Education, 2011.
2. Fred Luthans, "Organisational Behaviour", 11th edition, Mc Graw Hill, 2009.

14.	
REFERENCE BOOKS:	
1.	W. Newstrom, John, "Organisational Behaviour", 10th edition, Tata Mc Graw –Hill 2009.
2.	Paul Heresy, Kenneth H. Blanchard, and Dewey E. Johnson, "Management of Organisational Behaviour", Leading Human Resources, 2008.
3.	Dr S S Khanka, "Organisational Behaviour", S. Chand & Co, New Delhi, 2008.
4.	Sanghi Seema, "Organisational Behaviour", Pearson, 2011.

TAXATION FOR ENGINEERS

Course Code:	**MG1505-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	To make students understand the overview of Income Tax Law in India.
2.	To make students understand the basic concepts of income tax such as residential status, tax incidence.
3.	To make students understand the income tax provisions involved in determination of income from salary, House property, business and profession, capital gain and other sources.
4.	To help students understand the determination of tax liability Individual assessees.
5.	To make students understand the deductions u/s 80.

15.

UNIT-I

Basic concepts and Explanation under various Heads of Income	**15 Hours**

Basic concepts: Assessment Year, Previous Year, Person, Assessee, Income, Charges on Income, Gross Total Income, Capital and Revenue Receipts, Residential status, Connotation of income, Deemed to accrue or arise in India, Incidence of tax, Tax Planning, Tax Evasion, Tax Management. (Problems on Residential Status of Individual assessee)

Explanation under various Heads of Income: Income from Salary (theory, basic and full-fledged problems on allowances, perquisites and retirement benefits)

UNIT II

Income under the head Profit and gains of Business or Professions and Income under Capital Gain	**15 Hours**

Income under the head Profit and gains of Business or Professions and its computation - basis - Method of accounting - Scheme of business deductions/ allowance - Deemed profits - maintenance of books, (Problems on computation of Income from Business/ Profession of Individual assessee)
Income under Capital Gain: Basis of charge, Transfer of capital asset, inclusion & exclusion from Capital Asset, Capital Gain, Computation of Capital Gains (theory & problems), Exemptions/deductions from capital gains

UNIT III

Income from House Property and Other Sources	**10 Hours**

Income from House Property - Basic problems on House Property
Income from Other Sources (theory only)
Deductions under section 80C to 80U (No problems - Provisions only)

Course Outcomes: At the end of the course student will be able to

1.	Exhibit an understanding of the Income Tax Law in India.
2.	Identify the nature of Incomes and their tax incidence.
3.	Demonstrate how to determine the income from salary, house property, business and profession, capital gain.
4.	Demonstrate the determination of tax liability of Individual assessees.
5.	Exhibit a clear understanding of various provisions of deductions u/s 80.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1505-1-1.1	2	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.2	2	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.3	3	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.4	3	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.5	3	-	-	-	-	1	-	-	1	-	2	1

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Vinod Singhania, "Students Guide to Income Tax", Taxman Publications.
2.	Mehrotra & Goyal, "Direct Tax", Sahitya Bhavan.
3.	Lal & Vashisht, "Direct Tax", Pearson Ed. 28E.
4.	V S Datey, "Indirect Taxes", Taxman Publications.
5.	Vinod Singhania, "Direct Taxes", Taxman Publications.
6.	T N Manoharan, "Students Guide to Income Tax", Snow White.
7.	Kul Bushan, "How to deal with VAT", Pearson Education/PHI, 1/e.
8.	Mahesh Chandra & Shukla , "Income Tax Law & Practice", Pragathi Publications.
9.	Dr.Pillai, "VAT", Jaico Publications.

WORKING CAPITAL MANAGEMENT

Course Code:	**MG1506-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Need of the Course: The course will enable the student to manage activities in the area of working capital in an enterprise and help the students to do advance study in the field of financial-management through detailed analysis of financial statements, liquidity crises, cash optimization, credit analysis etc. The student will learn how to apply sound techniques for managing inventory.

Description of the Course: Every business needs adequate liquid resources in order to maintain day-to-day cash flow. It needs enough cash to pay wages and salaries as they fall due and to pay creditors if it is to keep its workforce and ensure its supplies. Maintaining adequate working capital is not just important in the short-term. Sufficient liquidity must be maintained in order to ensure the survival of the business in the long-term as well. Even a profitable business may fail if it doesn't have adequate cash flow to meet its liabilities as they fall due.

Teaching Department: Management

Course Objectives:

1.	Discuss the importance of working capital management.
2.	Evaluate working capital requirement.
3.	Assess the challenges faced in managing working capital in domestic and international operations.
4.	Plan for financing working capital requirement.

16.

UNIT-I

Working Capital Decisions, Working Capital Management and Sources of Working Capital	**15 Hours**

Working Capital Decisions: Meaning, Concepts, components Importance & types of working Capital.
Working Capital Management: Meaning, objectives, Principles, Importance of adequate working capital & consequences of inadequate working capital, Dangers of excessive working capital, determinants of working capital - operating cycle and Cash cycle. Approaches to determine an appropriate financing mix, Estimation of working capital requirements (problems) important working capital ratios.
Sources of Working Capital: Financing of long term working capital & short term working capital. Factoring - Meaning mechanism, Functions, types, merits & demerits.

UNIT II

Liquidity Management and Receivable Management	**15 Hours**

Liquidity Management: Cash Management - Meaning - Objectives of Cash Management - Nature of Cash - Motives of holding cash - Cash Management planning aspects - Cash

Budgets (Problems), Cash Management control aspects - Concentration banking - Lock box system - Playing the float - Cash Management models - William J Baumol Model - Miller-Orr Model (Problems using these models)

Receivable Management: Definition, Objectives, cost and benefits of receivable. Credit policy & its variables. Types of Credit policy & their merits & demerits, Factors influencing the size of investment in receivables. Control of receivables. Framing optimum credit policy & Average collection period (Problems)

UNIT III

Inventory Management	**10 Hours**

Meaning of Inventory - Need/Purpose of holding inventory - Benefits of holding inventory - Risk and cost of holding inventory - Management of Inventory - Objectives of Inventory Management - Techniques of Inventory Management - Economic Order Quantity (EOQ) - Determination of Stock levels - ABC analysis - Just in Time (JIT).

Course Outcomes: At the end of the course student will be able to

1.	Understand the meaning of working capital
2.	Realize the importance of management of working capital in an organization
3.	Learn about some key liquidity ratios used to understand more about a business' working capital position
4.	Understand various techniques used to manage working capital.
5.	Be aware of the techniques of cash, inventory and receivables management.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1506-1-1.1	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.2	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.3	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.4	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.5	2	-	-	-	-	1	-	-	-	1	2	1

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Sekhar Satya G.V., "Working Capital Management", 1/e; New Delhi: Wiley, 2014.
2.	Bhalla V. K., "Working Capital Management", 1/e; New Delhi: S. Chand Publishing, 2014.
3.	Sagner James S., "Working Capital Management, Applications and Cases", 1/e, New Delhi: Wiley, 2015.

NANOTECHNOLOGY

Course Code:	**PH2501 -1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH1001 -1**		

Teaching Department: PHYSICS

Course Objectives:

1.	To understand the basic scientific concepts of nanoscience, properties of nano materials, synthesis and fabrication of nano materials.
2.	To understand the various characterization techniques of nano materials.
3.	Study of carbon nano technology and its characterizations.
4.	To understand the applications of nano technology in various science, engineering and technology fields.

UNIT-I

Properties of Materials	**07 Hours**

Introduction: History of nano science, definition of nano meter, nanomaterials, nano technology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes, Band structure.

Properties Of Materials: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.

Synthesis and Fabrication	**08 Hours**

Synthesis of bulk polycrystalline samples, growth of single crystals, Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography, Requirements for realizing semiconductor nano structure, growth techniques for nano structures.

UNIT-II

Characterization Techniques	**15 Hours**

X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy (TEM), scanning probe microscopy (SEM), atomic force microscopy (AFM), piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, UV-VIS-IR Spectrophotometers, Magnetic and electrical measurements and Infrared/ Raman, EPR and NMR

UNIT-III

Carbon Nano Technology	**05 Hours**

Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nano crystalling diamond films, grapheme, and applications of carbon nano tubes.

Applications of Nano Technology	**05 Hours**
Applications in material science, biology and medicine, surface science, energy and environment. Applications of nano structured thin films, applications of quantum dots.	

Course Outcomes: At the end of the course student will be able to

1.	Ability to choose the appropriate nano material to meet the requirerment of a particular application.
2.	Identify the essential concepts used in nanotechnology.
3.	Identify the materials, properties, synthesis and fabrication of nanomaterials.
4.	Understand the various characterization techniques of nano materials.
5.	Applications of nanomaterials in various fields

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
PH2501-1.1	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.2	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.3	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.4	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.5	3	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	M.S. Ramachandra Rao, Shubra Singh, "Nano science and nano technology", Wiley publishers.

REFERENCE BOOKS:

1.	Charles P. Poole, Jr. Frank J. Owens, "Introduction to Nano Technology", Wiley publishers.
2.	Jermy J Ramsden, "Nanotechnology", Elsevier publishers.
3.	A. K. Bandyopadhyay, "Nano Materials", New Age publishers.
4.	T. Pradeep, "Nano Essentials", TMH.
5.	M. A. Shah, "Nanotechnology the Science of Small", Wiley publishers.
6.	Phani Kumar, "Principles of Nanotechnology", Scitech.

E Books / MOOCs/ NPTEL

1.	https://youtu.be/ebO38bbq0_4
2.	https://youtu.be/0MzIh7wkgMs

OPTOELECTRONIC DEVICES

Course Code:	**PH2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH1001 -1**		

Teaching Department: PHYSICS

Course Objectives:

1.	To understand the basic principles of construction, working and applications of various optoelectronic devices.
2.	Study of sources of radiation like lasers and LED, their specific properties and hence their use for applications.
3.	Study of radiation detectors like semiconductor detector, diode as detector and photo multiplier.
4.	Understanding the fabrication and applications of optical fibers, optical modulators and waveguides for optical communication

UNIT-I

Optical processes in Semiconductor, Display devices & Optical fibers	**15 Hours**

Elements of optical phenomena in Semiconductors- fundamentals of Fermi-Dirac distribution, band structure, direct and indirect band gap semiconductors, generation-recombination mechanisms, absorption and emission processes.
Display devices- cathode ray tube, liquid crystal display, charge coupled devices, plasma display.
Optical fibers- types of fibers, modes of propagation, attenuation and losses, optical fiber communication system, advantages.

UNIT-II

Optical Sources and Detectors	**15 Hours**

Lasers- basic principles, optical resonator-types, modes and quality factor, practical lasers-Nd-YAG, CO2, Excimer laser, Semiconductor laser- basic structure, laser action, heterojunction laser, quantum well laser, applications.
Light emitting diode- electroluminescence in p-n junction, LED characteristics, efficiency and responsivity, Heterojunction LED, Surface-Emitting LED and Edge emitting LED.
Photo detectors- photo conductor detector, junction photo diode, p-i-n photo diode, avalanche photo diode. Photo multiplier tube.

UNIT-III

Integrated Optics and Modulators	**10 Hours**

Modulation of light- Analog and digital modulation, Direct modulation - using LED and Semiconductor diode laser (SDL). External modulation - Electro-optic modulators (Pockels effect), Electro-absorption modulators. Acousto-optic modulation. Waveguides- device structure, waveguide devices – waveguide lenses, light bending devices, optical power dividers, directional couplers, waveguide polarizer, wavelength multiplexers and demultiplexers. Waveguide coupling. Optoelectronic integrated circuit

Course Outcomes: At the end of the course student will be able to

1.	Ability to choose the appropriate device to meet the requirement of a particular application.
2.	Making modifications to device structures by understanding the factors affecting their performance.
3.	Attempting better efficiency and utility through an understanding of the principles of performance.
4.	Use the technical knowledge acquired to troubleshoot and rectify devices and circuits.
5.	Explore the possibility of designing devices with better characteristics.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ **Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
PH2502-1.1	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.2	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.3	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.4	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.5	3	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	P.R.Sasikumar, "Photonics – an introduction", PHI Learning Pvt. Ltd.,New Delhi, 2012 edition.
2.	Pallab Bhattacharya, "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 2006.

REFERENCE BOOKS:

1.	J.Wilson and J.Haukes, "Opto electronics- an introduction", Prentice Hall of India, New Delhi.
2.	Jasprit Singh, '"Opto electronics- an introduction to Materials and Devices", McGraw Hill international ed., 1998.
3.	A.Ghatak and Thyagarajan, "Introduction to opto electronics", New Age International Publication.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/115102026/

AUTONOMOUS MOBILE ROBOTS

Course Code:	**RI2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1, ME 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Explain different types of locomotion in mobile robots to obtain a required task.
2.	Understand the different types of kinematics and dynamics involved in a mobile robot.
3.	Study the different types of sensors used in an autonomous mobile robot.
4.	Understand the different types of algorithms to identify the position of the mobile robot.
5.	Understand the various algorithms for planning and navigation of the mobile robot.

UNIT-I

Robot locomotion	**07 Hours**
Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, and controllability.	
Mobile robot kinematics and dynamics	**09 Hours**
Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.	

UNIT-II

Perception	**07 Hours**
Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.	
Localization	**07 Hours**
Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, and positioning beacon systems.	

UNIT-III

Introduction to planning and navigation	**10 Hours**
Path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).	

Course Outcomes: At the end of the course student will be able to

1.	Explain different types of locomotion in mobile robots to obtain a required task.
2.	Identify the different types of kinematics and dynamics involved in a mobile robot.
3.	Apply the different types of sensors used in an autonomous mobile robot.
4.	Apply the different types of algorithms to identify the position of the mobile robot.
5.	Apply the various algorithms for planning and navigation of the mobile robot to reach the destination.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
RI2501-1.1	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.2	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.3	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.4	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.5	3	3	3	3	2	1	-	-	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.
2. Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms in MATLAB", Springer Tracts in Advanced Robotics, 2011.
3. S. M. LaValle, “Planning Algorithms”, Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/)

REFERENCE BOOKS:

1. Thrun, S., Burgard, W., and Fox, D., "Probabilistic Robotics". MIT Press, Cambridge, MA, 2005.
2. Melgar, E. R., Diez, C. C., "Arduino, and Kinect Projects: Design, Build, Blow Their Minds", 2012.
3. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementations", PHI Ltd., 2005.

E Books / MOOCs/ NPTEL

1. https://archive.nptel.ac.in/courses/112/106/112106298/
2. https://www.edx.org/course/autonomous-mobile-robots

MEDICAL ROBOTICS
(For All except AI)

Course Code:	**RI2502-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH 1001-1, IS 1001-1, CY 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the types of medical robots used in the field of healthcare.
2.	Explain the various localization and tracking sensors
3.	Understand the applications of surgical robots with the help of few case studies
4.	Understand Rehabilitation of limbs and brain machine interface with the help of few case studies
5.	Understand the design methodology of medical robots.

UNIT-I

Introduction	**07 Hours**

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare. Localization And Tracking

Position sensors requirements	**09 Hours**

Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic -Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking

UNIT-II

Control Modes Radiosurgery	**07 Hours**

Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

Rehabilitation	**07 Hours**

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies.

UNIT-III

Design of Medical Robots	**10 Hours**

Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security

Course Outcomes: At the end of the course student will be able to

1.	Describe the types of medical robots and the concepts of navigation and motion replication.
2.	Describe about the sensors used for localization and tracking
3.	Explain the applications of surgical robots
4.	Explain the concepts in Rehabilitation of limbs and brain machine interface

5.	Classify the types of assistive robots and analyze the design characteristics, methodology and technological choices for medical robots.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
RI2502-1.1	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.2	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.3	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.4	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.5	3	-	3	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control", Wiley Publishers, 2006.
2.	Paula Gomes, "Medical robotics- Minimally, Invasive surgery", Woodhead, 2012.
3.	Achim Schweikard, Floris Ernst, "Medical Robotics", Springer, 2015.

REFERENCE BOOKS:

1.	Jocelyne Troccaz, "Medical Robotics", Wiley-ISTE, 2012.
2.	Vanja Bonzovic, "Medical Robotics", I-tech Education publishing Austria, 2008.
3.	Daniel Faust, "Medical Robotics", Rosen Publishers, 2016.
4.	Jocelyne Troccaz, "Medical Robotics", Wiley, 2013.

E Books / MOOCs/ NPTEL

1.	https://www.futurelearn.com/courses/medtech-ai-and-medical-robots
2.	https://web.stanford.edu/class/me328/

PLC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS

(For All except AI)

Course Code:	**RI2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To understand the fundamentals of fluid power transmission systems
2.	To design various hydraulic system components.
3.	To design various pneumatic system components.
4.	Learn various types of hydraulic and pneumatic power circuits.
5.	Learn various types of applications in fluid power circuits using PLC.

UNIT-I

Fluid power systems and fundamentals	**06 Hours**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, General types of fluids - Properties of hydraulic fluids -Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law

Hydraulic system components	**05 Hours**

Sources of Hydraulic Power: Pumping theory - Pump classification - construction and working of pumps - Variable displacement pumps, pump performance. Actuators: Linear hydraulic actuators-Single acting and double acting cylinders, Rotary actuators - Fluid motors.

Control Components	**04 Hours**

Direction control valve - Valve terminology - Various center positions. Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve. Flow control valves - Fixed and adjustable Safety valves.

UNIT-II

Pneumatic system components	**07 Hours**

Pneumatic Components: Properties of air. Compressors. FRL Unit -Air control valves, Quick exhaust valves and pneumatic actuators- cylinders, air motors. Basics of low-cost automation

Fluidics & Pneumatic circuit design	**08 Hours**

Fluidics - Introduction to fluidic devices, simple circuits. Introduction to Electrohydraulic Pneumatic logic circuits, PLC applications in fluid power control, Sequential circuit design for simple applications using classic, cascade, logic with Karnaugh- Veitch Mapping and combinational circuit design methods.

UNIT-III

Fluid power circuits	**10 Hours**

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

Course Outcomes: At the end of the course student will be able to

1.	Compare the basics of hydraulics to the performance of fluid power systems
2.	Explain the working principle of hydraulic systems including pumps and control components.
3.	Explain the working principle of pneumatic systems and their components.
4.	Design various types of Electrohydraulic and electro pneumatic circuits
5.	Design various types of applications in fluid power circuits using PLC.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
RI2503-1.1	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.2	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.3	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.4	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.5	3	2	3	2	3	-	-	-	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Majumdar S.R., "Pneumatic systems - Principles and maintenance", Tata McGraw Hill, 2008.
2.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2009.

REFERENCE BOOKS:

1.	Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.
2.	Harry L. Stevart D. B, "Practical guide to fluid power", Taraoeala sons and Port Ltd.Broadey, 2010.
3.	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 2011.
4.	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 2011.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108/105/108105088/
2.	https://plc-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
3.	http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/COEP_KNOWLEDGE_SEEKERS/labs/exp1/theory.html