NITTE EDUCATION TRUST | NMAM INSTITUTE OF TECHNOLOGY

College Calendar 2024-25

Department of Electrical & Electronics Engineering

Syllabus of 4th Year

NITTE EDUCATION TRUST | NMAM INSTITUTE OF TECHNOLOGY

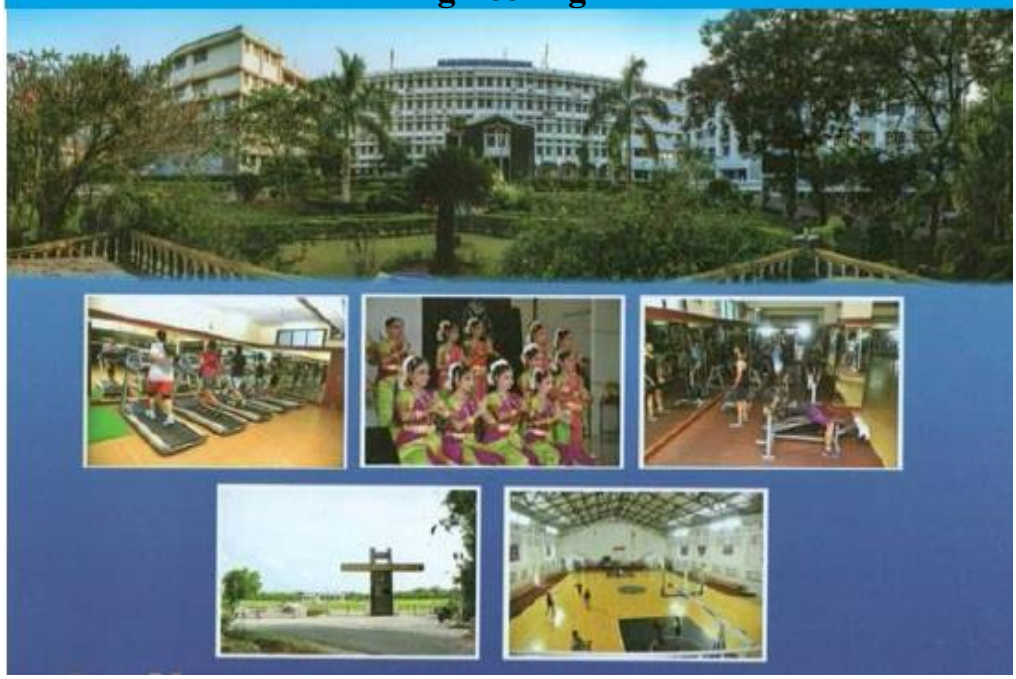
(An Autonomous Institution affiliated to Visvesvaraya Technological University, Belagavi)

Nitte - 574110, Karnataka, India

ISO 9001: 2015 Certified, Accredited by NAAC with 'A' Grade

VII & VIII SEMESTER

Department of Electrical & Electronics Engineering



College Calendar 2024-25

मातेव रक्षति पितेव हिते नियुङ्क्ते
कान्तेव चापि रमयत्यपनीय खेदम् ।
लक्ष्मीं तनोति वितनोति च दिक्षु कीर्तिं
किं किं न साधयति कल्पलतेव विद्या ॥

ಮಾತೇವ ರಕ್ಷತಿ ಪಿತೇವ ಹಿತೇ ನಿಯುಂಕ್ತೇ
ಕಾಂತೇವ ಚಾಪಿ ರಮಯತ್ಯಪನೀಯ ಖೇದಮ್ ।
ಲಕ್ಷ್ಮೀಂ ತನೋತಿ ವಿತನೋತಿ ಚ ದಿಕ್ಷು ಕೀರ್ತಿಂ
ಕಿಂ ಕಿಂ ನ ಸಾಧಯತಿ ಕಲ್ಪಲತೇವ ವಿದ್ಯಾ ॥

ತಾಯಿಯಂತೆ ರಕ್ಷಣೆಯನ್ನಿತ್ತು, ತಂದೆಯಂತೆ ಸನ್ಮಾರ್ಗದಲ್ಲಿ ತೊಡಗಿಸಿ ಪತ್ನಿಯಂತೆ ದುಃಖವನ್ನು ದೂರಮಾಡಿ ಮನಕ್ಕೆ ಮುದಕೊಡುತ್ತಾ, ಸಂಪತ್ತನ್ನು ವರ್ಧಿಸಿ ದಶದಿಕ್ಕುಗಳಲ್ಲಿ ಕೀರ್ತಿಯನ್ನು ಪಸರಿಸುವ 'ವಿದ್ಯೆ', ಕಲ್ಪಲತೆಯಂತೆ ನಾವು ಬಯಸಿದ್ದನ್ನು ಕೊಡುತ್ತಾಳೆ.

विद्या माता की तरह पालन करती है, बाप के तरह हितकर मार्ग में ही ले लेता है। पत्नी की तरह हमारा दुःख दूर करता है। मन को संतोष देता है, धन देती है, दिशाओं में कीर्ति फ़ैलाती है । कल्पवल्ली की तरह वह सब कामनाये पूरी करती है ।

Do you know in how many ways the 'Knowledge' serves his master? Like mother it protects, like father it teaches and guides, like wife, provides all kinds of happiness after destroying all sorrows, it brings wealth from every corner and spreads the fame in all direction. Like 'Kalpalatha' knowledge offers everything to human being whatever he wishes.

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COLLEGE CALENDAR
2024-25
(VII & VIII Semester)

NITTE EDUCATION TRUST | NMAM INSTITUTE OF TECHNOLOGY

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Vision Statement

Pursuing Excellence, Empowering people, Partnering in Community Development

Mission Statement

To develop N.M.A.M. Institute of Technology, Nitte, as Centre of Excellence by imparting 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 Memorium

Late Nitte Mahalinga Adyanthaya

Our Founder

Late Justice K. S. Hegde

1909-1990

SRI N. VINAYA HEGDE

President, Nitte Education Trust
Chancellor, Nitte (Deemed to be University), Mangaluru

NITTE EDUCATION TRUST | NMAM INSTITUTE OF TECHNOLOGY

Sl.No.	Name of the Faculty	Designation
1.	Dr. N. Niranjan Chiplunkar	Principal
2.	Mr. Yogeesh Hegde	Director(CM&D)
3.	Dr. Shrinivasa Rao B. R.	Vice Principal/Controller of Examinations/Professor
4.	Dr. I. Ramesh Mithanthaya	Vice Principal / Dean (Academic)/Professor
5.	Dr. Sudesh Bekal	Dean (R&D)/Professor
6.	Dr. Rajesh Shetty K.	Dean (Admissions)/Professor
7.	Dr. Rekha Bhandarkar	Deputy Registrar of Nitte Off-campus Centre, Nitte (DU)
8.	Dr. Subrahmanya Bhat K	Deputy COE of Nitte Off-campus Centre, Nitte (DU)
9.	Dr. Nagesh Prabhu	Director(Curriculum Development) Nitte (DU)
10.	Dr. Srinath Shetty K.	Resident Engineer/Professor
11.	Dr. Narasimha Bailkeri	Dean(Student Welfare)/Professor
12.	Dr. Rajalakshmi Samaga BL	PG Coordinator/Professor

HEADS OF DEPARTMENTS

1.	Dr. Arun Kumar Bhat	HoD, Civil Engg.
2.	Dr. Jyothi Shetty	HoD, Comp. Science & Engg
3.	Dr. Ashwini B	HoD, Information Science & Engg
4.	Dr. Ujwal P	HoD, Biotechnology
5.	Dr. KVSSSS Sairam	HoD, E&C Engg.
6.	Dr. Suryanarayana K	HoD, E&E Engg.
7.	Dr. Muralidhara	HoD, Robotics & Artificial Intelligence
8.	Dr. Kumudakshi	HoD, Mathematics
9.	Dr. Shobha R. Prabhu	HoD, Physics
10.	Dr. Shivaprasad Shetty M.	HoD, Chemistry
11.	Dr. Mamatha Balipa	HoD, MCA
12.	Dr. Vishwanatha	HoD, Humanities
13.	Dr. Radhakrishna	HoD, Computer & Communication Engg
14.	Dr. Sharada Uday Shenoy	HoD, Artificial Intelligence & Machine Learning

15.	Dr. Srinivas Pai P	HoD, Mechanical Engg
16.	Dr. Venugopala PS	HoD, Artificial Intelligence & Data Science
17.	Dr. Roshan Fernandes	HoD, Cyber Security
18.	Dr. Durgaprasad	Incharge ACT
19.	Dr. Sushma	Incharge VLSI
20.	Mr. Bharath G Kumar	Head, Training & Placement Cell

INCHARGE OF INSTITUTION'S RESPONSIBILITIES

1.	Dr. Gururaj Upadhyaya	Workshop Suptd
2.	Dr. Joy Elvine Martis	1st year Coordinator
3.	Dr. Jnaneshwar Pai Maroor	Coordinator Alumni
4.	Dr. Venkatesh Kamath	Assistant CoE
5.	Dr. Janardhan Nayak	Coordinator – Red Cross Unit
6.	Mr. Srinivas Nekkar	NCC Officer
7.	Mr. Krishnaraja Joisa	Public Relation Officer
8.	Mr. K. Sathish Nayak	Digital Media Executive
9.	Dr. Shashikanth Karinka	Student Welfare Officer
10.	Dr. Vijeesh	Director (R&D)

ENTREPRENEURSHIP DEVELOPMENT CELL

1.	Dr. Ramakrishna B	Professor/EDC- Incharge
2.	Mrs. Geetha Poojarthi	Coordinator

DEPARTMENT OF TRAINING & PLACEMENT

1.	Mr. Ankith S Kumar	Counsellor
2.	Dr. Abhishek Bhardwaj	T&P Associate

DEPARTMENT OF MATHEMATICS

1.	Dr. Shashirekha B. Rai	Professor
2.	Dr. Kumudakshi	Asso. Professor/ HoD
3.	Dr. Sharad M. Hegde	Asst. Professor Gd III
4.	Dr. Vasanth K.R	Asst. Professor Gd III
5.	Dr. Ashwini Kumari	Asst. Professor Gd III

6.	Dr. Chaithra K.	Asst. Professor Gd III
7.	Dr. Prashanthi K S	Asst. Professor Gd III
8.	Dr. Girija K P	Asst. Professor Gd III
9.	Dr. Ganesh Kumar K	Asst. Professor Gd III
10.	Mrs. Ambika N.	Asst. Professor Gd I
11.	Mrs. Vinaya Acharya	Asst. Professor Gd I
12.	Mrs. Anitha D. Bayar	Asst. Professor
13.	Mrs. Bhavya K.	Asst. Professor
14.	Mrs. Bhavya. D.	Asst. Professor
15.	Mrs. Sharmila	Asst. Professor
16.	Mrs. Anjana Pai K	Asst. Professor
17.	Mrs. Soumya	Asst. Professor
18.	Mrs. Smitha G. V.	Asst. Professor

DEPARTMENT OF PHYSICS

1.	Dr. Manjunath K. B.	Professor
2.	Dr. Shobha R. Prabhu	Asso. Professor / HoD
3.	Dr. Sathyajith	Asso. Professor
4.	Dr. Raghavendra Bairy	Asso. Professor
5.	Dr. Nagaraja B.S.	Asst. Professor Gd III
6.	Dr. Shyam Prasad . K.	Asst. Professor Gd III
7.	Dr. Saritha Suvarna	Asst. Professor Gd III
8.	Dr. Murari M S	Asst. Professor Gd III

DEPARTMENT OF CHEMISTRY

1.	Dr. Janardhana Nayak	Professor
2.	Dr. Ramesh Bhat	Asso. Professor
3.	Dr. Shivaprasad Shetty M.	Asso. Prof/HoD
4.	Dr. Santhosh Tiwari	Asso. Professor
5.	Dr. Aarti S. Bhat	Asst. Professor Gd III
6.	Dr. Subrahmanya Ishwar Bhat	Asst. Professor Gd III
7.	Dr. Sarvajith MS	Asst. Professor Gd III
8.	Dr. Ranjitha	Asst. Professor Gd III
9.	Dr. Shreya Kamath	Asst. Professor Gd III

DEPARTMENT OF HUMANITIES

1.	Dr. Ramakrishna B.	Professor
2.	Mrs. Rashmi D. Hegde	Asso. Professor
3.	Dr. Vishwanatha	Asso. Professor /HoD
4.	Dr. Jnaneshwar Pai Maroor	Asst. Professor Gd III
5.	Dr. Joy Elvine Martis	Asst. Professor Gd III
6.	Mrs. Shyla D Mendonca	Asst. Professor Gd II
7.	Ms. Sonia Lobo	Asst. Professor Gd I
8.	Ms. Akshatha Kumari J Shetty	Asst. Professor Gd I
9.	Mr. Srinivas Nekkar	Asst. Professor
10.	Mrs. Shwetha	Asst. Professor

OFFICE SECTION HEADS

1.	Mr. Keshava Mugeraya	Sr. Suptd, Academic Section/ Purchase In -Charge
2.	Mrs. Suneetha R. Shetty	Sr. Suptd, Administrative Section
3.	Mr. Suresh Achar	Sr. Suptd, Stores
4.	Mrs. Jayashree	Sr. Programmer, Office Automation Cell
5.	Mrs. Shailaja V. Shetty	Suptd, Accounts Section
6.	Dr. Preetham Shetty KV	Librarian

SECURITY DEPARTMENT

1.	Mr. Hirianna Suvarna S	Security Supervisor

SPORTS DEPARTMENT

1.	Sri. Shyam Sundar M.	P.E.D
2.	Sri. Ganesh Poojary	P.E.D
3.	Ms. Sowjanya M.	P.E.I
4.	Mr. Ravi Prakash C. Anpur	Basket Ball Coach
5.	Mr. Clive Nolan Mascarenhas	Football Coach
6.	Mr. Rajesh Acharya	Cricket Coach

HOSTEL WARDENS

1.	Dr. Veena Devi S.V	Chief Warden, NET Ladies Hostels, Nitte
2.	Dr. Vishwanatha	Chief Warden, NET Gents Hostels, Nitte

HOSTEL SUPERINTENDENT / MANAGER

1.	Mr. Manjunatha Suvarna	Hostel Manager, Gents Main Hostel
2.	Mr. Rajesh Ballal	Manager, Gents PG Hostel
3.	Mrs. Gayathri Kamath	Manager, Ladies PG Hostel
4.	Mrs. Chethana Sharma	Manager, Ladies Main Hostel
5.	Mrs. Hema S. Hegde	Superintendent, Hostel Office
6.	Mr. Kiran Kumar Annappa Kulal	Hostel Manager, Gents Main Hostel

REGULATIONS

2024-25

(Applicable for admission batch 2021-22 onwards)

NITTE EDUCATION TRUST | NMAM INSTITUTE OF TECHNOLOGY

CONTENTS

REGULATIONS

REGULATIONS COMMON TO ALL B.E. (CREDIT SYSTEM) DEGREE PROGRAMMES OF NMAM INSTITUTE OF TECHNOLOGY, NITTE Karkala, Udupi Dist., Karnataka

1. INTRODUCTION

1.1 The general regulations are common to all B.E. (Credit System) Degree Programmes conducted at the NMAMIT, Nitte Campus and shall be called "NMAMIT 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 and evaluation and certification of student's 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 BE Degree program (of VTU) along with all the amendments thereto, and shall be binding on all students undergoing the Graduate Degree Programme(s) (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 In order 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 NMAMIT courses for

appropriate action, irrespective of whether a reference is made here in this set of Regulations or otherwise.

1.6 The course shall be called **Bachelor of Engineering** course abbreviated as B.E. (Subject of specialization) – Credit System.

1.7 **DURATION OF THE COURSE**

(a) The course shall extend over a period of total duration of 4 years.

(b) 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	Three; Two being Main semesters (odd, even) and one being a supplementary semester; after 2 main semesters. (Note: Supplementary semester is primarily to assist weak and / or failed students through make up courses. However, Autonomous Colleges may use this semester 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 19 Weeks; Supplementary Semester 8 Weeks
3. Academic Activities	Main Semester
(Weeks):	Registration of Courses & Course Work (16.0) Examination Preparation and Examination (3.0) Total (19) Supplementary Semester

	Registration of Courses & Course Work (5.0) Examination Preparation and Examination (3.0) Total (8) Declaration of results: 2 weeks from the date of last examination Inter- Semester Recess: After each Main Semester (2) Total Vacation: 10 weeks (for those who do not register for supplementary semester) and 4 weeks (for those who register for supplementary 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 also 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 course shall be fixed by the Senate from time to time, but preferably in line with the academic calendar of the VTU.

2. DEGREE PROGRAMMES

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

i)	**Biotechnology Engineering**	**(BT)**
ii)	**Civil Engineering**	**(CV)**
iii)	**Computer Science & Engineering**	**(CS)**
iv)	**Electronics & Communications Engineering**	**(EC)**
v)	**Electrical & Electronics Engineering**	**(EE)**
vi)	**Information Science & Engineering**	**(IS)**
vii)	**Mechanical Engineering**	**(ME)**
viii)	**Artificial Intelligence and Machine Learning Engg.**	**(AM)**
ix)	**Computer and communication Engineering**	**(CC)**
x)	**Robotics and Artificial Intelligence Engineering**	**(RA)**

Other teaching departments are –

i)	**Mathematics**	**(MA)**
ii)	**Physics**	**(PH)**
iii)	**Chemistry**	**(CY)**
iv)	**Humanities, Social Sciences and Management**	**(HU)**

2.2 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.

3. REGISTRATION

3.1 Every student after consulting his Faculty Advisor in parent department shall register approved courses (core and elective) to earn credits for meeting the requirements of 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 have to pay a late fee. Such courses together with their grade and credits earned will be included in the grade card issued by the college at the end of each semester, like odd, even, supplementary and it forms the basis for determining the student's performance in that semester.

3.2 Lower and Upper Limits for Course Credits Registered in a Semester Course Credit Assignment

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

Lecture / Tutorials / Practical:

i) One hour Lecture per week is assigned one Credit.

ii) 2-hour Tutorial session per week is assigned 1.0 Credit.

iii) 2-hour Lab. session 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

A student must register, as advised by Faculty Advisor, between a minimum of 15 credits and up to a Maximum of 25 credits.

3.3 Mandatory Pre-Registration for higher semester

In order to facilitate proper planning of the academic activities of the Semester, it is necessary for the students to 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 prior to the last working day of the semester.

Registration to a higher semester is allowed only if the student fulfills the following conditions -

i) satisfied all the academic requirements to continue with the programme of studies without termination

ii) cleared all Institute, hostel and library dues and fines, if any, of the previous semester

iii) paid all required advance payments of the Institute and the hostel for the current semester

iv) has not been debarred from registering on any specific grounds by the Institute.

4. ADD / DROP / AUDIT options

4.1 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 subject teacher and under faculty advice. The permissible course load to be either average credits (=20) or to be within the limits of minimum (=15) and maximum (=25) credits.

4.2 DROP-option

During a specified period at the middle of a semester student's performance in CIE is reviewed by the faculty advisor. Following 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 to be re-registered by these students and taken up for study at a later time.

4.3 Withdrawal from courses

During a specific period specified towards the end of the semester, student's performance in CIE is reviewed by the Faculty advisors. Following poor performance by a student in identified course (s) he/she is advised to withdraw from such course(s) (up to the minimum credits specified for the semester)

with mention in the Grade card (Grade 'W'). Such courses to be re-registered by these students and taken up for study at a later time.

4.4 AUDIT-option

A student can register for courses for audit only, with a view to supplement his/her knowledge and/or skills. The student's grades in such course(s) will have to be reflected in the grade card. However, CORE courses shall not be made available for audit. But these shall not be taken into account in determining the student's academic performance in the semester. 'U" grade is awarded to such courses on satisfying the attendance requirements and CIE requirements. The candidate need not appear for SEE in such courses.

5. COURSE STRUCTURE:

5.1 Typical Breakdown for the B.E. Degree Curriculum:

No.	Course Category	Credit Range
1.	Basic Science Courses	20-25
2.	Engineering Science Courses	18-22
3.	Humanity, Social Science and Management	8-12
4.	Ability Enhancement Courses	10-14
5.	Professional Core Courses (PCC)	40-45
6.	Professional Elective Courses (PEC)	8-12
7.	Open Elective Courses (OE)	8-12
8.	Skill Courses (Project Work / Internship / Seminar)	28-36
9.	Mandatory courses	2
Note: **Student can register between 15 to 25 credits per semester** **Total Credits to be earned : 160**		

5.2 The Department Undergraduate Committee (DUGC) will discuss and recommend the exact credits offered for the programme 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 senate for consideration and approval.

5.3 The earned Credit Requirement for the B.E. 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 student to plan their career.

5.4 Mandatory Learning Courses

These are courses that must be completed by the student at appropriate time or at his convenience. The 'PP' grade is awarded for a Pass in the course and 'NP' grade is awarded for a Fail in the course. In case 'NP' grade is awarded, the student has to re- register for the same course wherein he has no alternative options. However, he/she can opt for other courses if he/she has been provided with multiple options.

The 'PP' and 'NP' grades do not carry grade points and 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 record (transcript) with Pass or Fail (PP or NP).

Courses that come under this category are the following.

Moral and Ethical Values, Communication skills, Entrepreneurship Development Programme, Environmental issues, Proficiency in a Language etc.

Such courses will not carry any credits for the award of degree, but a pass in each of such course during the programme shall be a necessary requirement for the student to qualify for degree award.

5.5 PROJECT

i) Project work at 7^{th} semester shall be completed batch wise. The batch shall consist of a maximum of 4 students.

ii) Project viva-voce examination shall be conducted individually.

5.6 ELECTIVES

i) A candidate shall take electives in each semester from groups of electives, commencing from 6^{th} semester.

ii) The minimum number of students to be registered for any Elective offered shall not be less than ten.

iii) A candidate shall opt for his/her choice of electives and register for the same if pre-registration is not done, at the beginning of each of 6^{th} & 7^{th} semesters. The candidate is permitted to opt for change of elective within 15 days from the date of commencement of the semester as per the academic calendar of the college.

6. ATTENDANCE REQUIREMENT:

6.1 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 Principal for reasons such as medical grounds, participation in University level sports, cultural activities, seminars, workshops and paper presentation.

6.2 The basis for the calculation of the attendance shall be the period of term prescribed by the College by its calendar of events. For the first semester students, the same is reckoned from the date of admission to the course (as per CET/COMED-K or Management allotment).

6.3 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 the shortage.

6.4 A candidate having 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 'N' grade in these courses.

He/she shall have to repeat those course(s). Such students 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 supplementary semester.

6.5 **Attendance in CIE and SEE:** Attendance at 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.

7. WITHDRAWAL FROM THE PROGRAMME

7.1 Temporary Withdrawal

a) A student who has been admitted to a degree programme of the college may be permitted once during the course to withdraw temporarily, for a period

of 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 about the genuineness of the case and that even by taking into account the expected period of withdrawal, the student has the possibility to complete the programme 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 such time as 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 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.

7.2 Permanent Withdrawal

Any student who withdraws 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.

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

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

(c) The decision of the Principal of the College regarding withdrawal of a student is final and binding.

8. EVALUATION SYSTEM

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

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

8.3 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)

i) Quizzes, Tutorials, Assignments, Seminars, mini projects, tutorials etc. : 10 marks

ii) Mid-semester Examination : 40 marks

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

8.4 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 specified period in a semester.

8.5 The course Instructor shall announce in the class and/or display at the 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.

8.6 Passing standards

Evaluation Method	Passing Standard
Sessional (CIE)	Score: ≥40% (≥20 marks)
Terminal (SEE)	Score: ≥40% (≥20 marks)

i) 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 project evaluation committee at the department level shall form the SEE of the project work.

ii) In the case of other requirements, such as, seminar, industrial internship, field work, comprehensive viva voce, if any, the assessment shall be made as laid down by the Academic council.

iii) **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 want 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 E in each case. While such students should re-register for same course(s) if core, they can re-register for 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 a supplementary semester.

8.7

i) Absolute Grading – Letter Grade and its range

The grade point scale for absolute grading

Marks Range (%)	Grade Point	Letter Grade	Descriptor
90 & above	10	O	Outstanding
80-89	9	A+	Excellent
70-79	8	A	Very Good
60-69	7	B+	Good
55-59	6	B	Above Average
50-54	5	C	Average
40-49	4	P	Pass
00-39	0	F	Fails
Absent	0	AB	Absent

CGPA	Classification
7.00 & above	**First Class with Distinction**
6.00-6.99	**First Class**
5.00-5.99	**Second Class**
CGPA <5.00*	**Academic Probation / Non-compliance**

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.

8.8 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 S-E. Letter grade 'F' in any course implies failure of the student in that course and no credits earned.

8.9 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 (S-F) after the student completes the course requirements.

- Grade 'I': To a student having satisfactory attendance at classes and meeting the passing standard at CIE, 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, which required the student to be away from the College;

- 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 Make up Examinations within 2 working days of that particular examination for which he or she is absent, failing which they will not be given permission. This is admissible only for students who have more than 45 CIE marks.
- 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
- Grade 'X': To a student having attendance ≥85% and CIE rating (90%), in a course but SEE performance observed to be poor, which could result in a F grade in the course. **(No 'F' grade awarded in this case but student's performance record maintained separately).**

8.10 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.**

8.11 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. 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/ supplementary semester and fulfill the passing standards for their CIE and (CIE+SEE).

9. 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.

$$\text{SGPA} = \frac{\sum [\textit{(course credit) X (Grade point)] (for all courses in that semester)}}{\sum [\textit{(course credits)}]}$$

CGPA is computed as follows:

$$\text{CGPA} = \frac{\sum [\textit{(course credits)X (Grade points)] (for all courses excluding those with F grades until that semester)}}{\sum \textit{(course credits)] (for all courses excluding those with F grades until that semester)}}$$

10. 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 of them would be normally calculated to the second decimal position.

11. VERTICAL PROGRESSION (PROMOTION / ELIGIBILITY TO HIGHER SEMESTERS)

11.1 There shall be no restriction for promotion from an odd semester to the next even semester, provided the student has fulfilled the attendance requirement.

11.2 **A Student shall be declared fail if he / she**

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

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

11.3 **(A) Vertical Progression in case of students admitted to First year:**

(a) Students having not more than four F grades in the two semesters of first year of the Programme shall be eligible to move to second year.

(a.1) Students having not more than four F grades in the four semesters of I and II year shall be eligible to move to III year.

(a.2) Students who have earned all the prescribed credits of I year, and having not more than four grades in the four semesters of II and III year shall be eligible to move to IV year.

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

(a) Students having not more than four F grades (excluding the Fail or pass status of Additional Mathematics I and II) in the two semesters of II year of the Programme shall be eligible to move to III Year.

(a.1) Students having not more than four F grades (excluding the Fail or pass status of Additional Mathematics I and II, if any) in the four semesters of II and III year shall be eligible to move to IV year.

(b) The mandatory non-credit Courses Additional Mathematics I and II prescribed at III and IV semesters respectively, to lateral entry Diploma holders admitted to III semester of B.E/B.Tech. Programmes shall attend the classes during the

respective semesters to satisfy attendance and CIE requirements and to appear for the University examinations.

(b.1) In case, any student fails to satisfy the attendance requirement of the Courses Additional Mathematics I and II, he/she shall not be eligible to appear for the Semester End Examinations of that semester and shall not be permitted to take admission to next higher semester. The candidate shall be required to repeat that semester during the subsequent year.

(b.2) Students who have satisfied the attendance requirement but not the CIE requirements of the Courses Additional Mathematics I and II shall be permitted to register afresh and appear for SEE after satisfying the CIE requirements in the same Course/s (with or without satisfying the attendance requirement) when offered during subsequent semester/s.

(c) Completion of Additional Mathematics I and II shall be mandatory for the award of degree.

(C) Vertical Progression in case of B.Sc students admitted to Second year (Lateral entry):

(a) Students having not more than four F grades (excluding the Fail or pass status of Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme) in the two semesters of II year of the Programme shall be eligible to move to III year.

(a.1) Students having not more than four F grades (excluding the Fail or pass status of Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme, if any) in the four semesters of II and III year shall be eligible to move to IV year.

(b) The prescribed mandatory non-credit Courses Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme to lateral entry B. Sc holders admitted to III semester of B.E/B. Tech Programmes, shall attend the classes during the respective semesters to complete CIE and attendance requirements and to appear for the University examinations.

(b.1) In case, any student fails to satisfy the attendance requirement of the above said Courses; he/she shall not be eligible to appear for the Semester End Examinations of that semester and shall not be permitted to take admission to next higher semester. The candidate shall be required to repeat that semester during the subsequent year.

(b.2) Students who have satisfied the attendance requirement but not the CIE

requirements of the above said Courses, shall be permitted to register afresh and appear for SEE after satisfying the CIE requirements in the same Course/s (with or without satisfying the attendance requirement) when offered during subsequent semester/s.

(c) Completion of Engineering Graphics and Elements of Civil Engineering and Mechanics shall be mandatory for the award of degree.

The Principal of each college shall make suitable arrangements in the timetable to facilitate the B. Sc students to attend the above mentioned courses to satisfy the CIE and attendance requirements and to appear for the University examinations.

11.4 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 CGPA = 5.0 on three consecutive occasions.

ii) Failure to earn a credit of 160 (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.

12. 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
≥ 7.75	≥ 70%	Distinction
≥ 6.75	≥ 60%	First Class
< 6.75	< 60%	Second Class

Percentage = (GPA - 0.75) x 10

13. 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.

14. AWARD OF DEGREE

14.1 (1) B.E. Degree

a) Students shall be declared to have completed the Programme of B.E./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) Completion of Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme shall be mandatory for the award of degree to lateral entry B.Sc. graduates.

e) (i) Over and above the academic credits, every Day College regular student admitted to the 4 years Degree Programme and every student entering 4 years Degree Programme through lateral entry, shall earn 100 and 75 Activity Points respectively through AICTE Activity Point Programme for the award of degree. Students transferred from other Universities/Autonomous colleges under VTU to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eight semester Grade Card.

(ii) Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be

considered for vertical progression.

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.

(2) B.E. (Honors) Degree

VTU, Belagavi has framed the guidelines for applying for the award of Bachelor of Engineering (Honors) degree.

These Regulations are applicable for the following students:

1. Admitted to **I semester** / I year from the academic year **2018-19** (i.e. USN XXX18XXXXX)
2. Admitted to **III semester** / II year from the academic year **2019-20** (i.e. USN XXX19XX4XX)
3. These Regulations are uniformly applicable to Affiliated, Autonomous and Constituent Colleges under VTU.

Eligibility criterion

(i) Students have to earn 18 or more additional credits through MOOCs.

(ii) Students shall register for this course from fifth semester onwards.

(iii) Students shall obtain a grade $\geq$ D in all the courses in first attempt only in all the semesters till 5th.

(iv) Students shall obtain CGPA of 8.5 and above at the end of fourth semester.

(v) For Diploma students, they shall complete Additional Mathematics I and II during 3rd and 4th semesters in first attempt only.

Requirements:

(i) Students shall maintain a grade $\geq$D in all courses from 5thto 8thsemester in 'first attempt' only.

(ii) Students not having CGPA greater than or equal to 8.5 at the end of the B.E. programme shall not be eligible for the award of Honors degree, even if they have satisfied the requirement of additional credits.

(iii) Students shall take up additional course work, other than the regular courses prescribed by the University from 5thto 8thsemester from NPTEL

and other platforms notified by the University and complete the same in any number of attempts with a final score (online assignments: 25 % + Proctored examination: 75 %) leading to the following certificates – ELITE (60 to 75 %) or ELITE + SILVER (76 to 89 %) or ELITE + GOLD (≥ 90 %) before closure of eighth semester as per the academic calendar.

(iv) Students shall be permitted to drop the registered course work (s) and select alternative course work (s) in case they cannot give proctored examination.

(v) Students have to take courses from the list of MOOCs approved by the University, which can be from NPTEL / SWAYAM / other platforms.

(vi) Students shall select courses in consultation with their Class Advisor, such that the content / syllabus of them are not similar to that of the core courses, professional electives or open electives, which the students may chose in the program.

(vii) Students shall earn the additional credits for these courses through MOOCs, by only appearing in person to the proctored examinations conducted by NPTEL / SWAYAM / other platform. The method of assessment shall be as per NPTEL online platform.

(viii) The Credit equivalence shall be as follows - 4 weeks of online course duration – 1 credit, 8 weeks of online course duration – 2 credits and 12 weeks of online course duration – 3 credits.

Registration:

(i) Any student meeting the eligibility criteria and interested to register for Honors degree qualification shall apply to the University through the Principal in the prescribed form along with the prescribed application fees within 15 working days after notification by the University.

(ii) The Registrar shall notify the registration of the student and it will be notified to the student and the student shall pay a one-time, non-refundable registration fees as prescribed by the University to confirm the registration.

Award of Honors Qualification:

(i) Students who successfully complete the MOOCs prescribed by the University and submit their E-certificates to the University through the Principal against the notification issued by the Registrar in time before the closure of eighth semester, as per the academic calendar shall be eligible for B.E. (Honors) degree. If a student does not submit the certificates in

time on or before the last date, their request shall not be considered, even if they have earned the requisite number of credits.

(ii) The Honors degree shall be awarded only if the CGPA at the end of the B.E. programme is equal to or greater than 8.5.

(iii) A student who has earned the requisite number of credits and who has submitted the certificates in time and has been accepted by the University will get B.E. degree with Honors suffixed indicating recognition of higher achievement by the student concerned.

(iv) Further students fulfilling all the above requirements shall be entitled to receive their transcripts indicating both the achievement of the student concerned.

(v) The award of the Honors degree shall be recommended by the Academic Senate and approved by the Executive Council of the University.

14.2 (1) Noncompliance of CGPA ≥ 5.00 at the end of the Programme

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

(b) In the cases of 14.2 (1) a, students shall be permitted to appear again for SEE in course/s (other than Internship, Technical seminar, Project (Mini and Main), and Laboratories) of any Semester/s without the rejection of CIE marks for any number of times, subject to the provision of maximum duration of the Programme to make up the CGPA equal to or greater than 5.00 for the award of the Degree.

(c) 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 14.2 (1) b

(d) 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 14.2 (1) b

(e) 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 14.2 (1) b

(f) In case, the students fail (i.e., earns 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 14.2 (1) b

(g) Students shall obtain written permission from the Registrar (Evaluation) to reappear in SEE to make up the CGPA equal to or greater than 5.00.

(2) Noncompliance of Mini-project

(a) The 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 fail in that course and shall have to complete the same during subsequent University examinations after satisfying the Mini-project requirements. Also, mini-project shall be considered for eligibility to VII semester.

(3) Noncompliance of Internship

(a) All the students of B.E/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation. A University examination shall be conducted during VIII semester. Internship 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 internship shall be declared fail in that Course and shall have to complete the same during subsequent University examinations after satisfy the internship requirements.

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

15 GRADUATION REQUIREMENTS AND CONVOCATION

15.1 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 centres**

c) **No disciplinary action pending against him/her.**

15.2 **The award of the degree must be recommended by the Senate**

15.3 **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.

16 AWARD OF PRIZES, MEDALS, CLASS & RANKS

For the award of Prizes and Medals, the conditions stipulated by the Donor may be considered as per the statutes framed by the College 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 12.

17 CONDUCT AND DISCIPLINE

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

17.2 **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.**

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

a) Ragging.
b) Lack of courtesy and decorum; indecent behaviour anywhere within or outside the campus.
c) Willful damage or stealthy removal of any property/belongings of the College/Hostel or of fellow students/citizens.
d) Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs.
e) Mutilation or unauthorized possession of Library books.

f) Noisy and unseemly behaviour, disturbing studies of fellow students.

g) 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 Cyber crime etc.).

h) Plagiarism of any nature.

i) Any other act of gross indiscipline as decided by the Senate from time to time.

j) Use of Mobile in the college Academic area.

k) Smoking in College Campus and supari chewing.

l) Unauthorized fund raising and promoting sales.

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.

17.4 For an offence committed in (i) a hostel (ii) a department or in a class room 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.

17.5 All cases involving punishment other than reprimand shall be reported to the Principal.

17.6 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.

18. EARNING OF ACTIVITY POINTS FOR THE AWARD OF DEGREE

18.1 As per VTU guidelines, every students entering 4 year degree programme should earn 100 activity points & every students entering 4 year degree programme through Lateral Entry should earn 75 activity points for the award of the Engineering Degree.

18.2 The Activity Points earned will be reflected on the student's eighth semester Grade Card.

18.3 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.

18.4 Activity Points (non-credit) have no effect on SGPA/CGPA point.

18.5 In case students fail to earn the prescribed Activity Points, Eighth semester Grade Card shall be issued only after earning the required Activity Points.

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.

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LIST OF MAJOR SCHOLARSHIPS

Applicable to	*Types of scholarship*	*Method*	*Website*
For SC/ST Students	*Income : Below Rs.2,50,000/-*	*Online application*	**SSP**
	Income : Above Rs.2,50,000/- to Rs.10,00,000/-		
For Others	*Category I : Income Below Rs.2,50,000/-*	*Online application*	
	Category 2A, 3A, 3B Income Below Rs.1,00,000/-	*Online application*	
	GSB & Brahmins EWS Certificate upto Rs.8,00,000/-	*Online application*	
	Minority students Income Below Rs.2,50,000/-	*Online application*	*NSP & SSP*
Parents must have Beedi Id. Card	*Beedi Scholarship*	*Online application*	**scholarships.gov.in or nsp.gov.in**

1. **Scholarship details will be published in the notice board near College Academic Section. Students must see the notice board and submit the application before due dates.**

2. **All SC/ST and Category I students who have not paid any fee in CET must apply for Fee concession or Scholarship. Otherwise they must pay the tuition fee and college fee.**

3. **The students, who are applying for any of the above scholarship through online, must submit the hardcopy with supporting documents (with attestation) to the academic section in time.**

NMAMIT, Nitte
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Scheme of Teaching and Examinations 2021
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2021-22)

VII Semester

SN	Course Category	Course Code	Course Title	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	21EE701	High Voltage Engineering	EE	3	0	0	0	3	50	50	100	3
2	PCC	21EE702	Industrial Drives and Applications	EE	2	2	0	0	3	50	50	100	3
3	PEC	21EEE1XX	Professional Elective - II	EE	3	0	0	0	3	50	50	100	3
4	PEC	21EEE2XX	Professional Elective - III	EE	3	0	0	0	3	50	50	100	3
5	OEC	21XX8xXX	Open Elective - II	EE	3	0	0	0	3	50	50	100	3
6	Project	21EE703	Project Work	EE	Two contact hours / week for interaction between the faculty and students				3	100	100	200	9
								TOTAL	**-**	**350**	**350**	**700**	**24**

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VIII Semester

SN	Course Category	Course Code	Course Title	Teaching Department	Teaching Hours / Week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	Seminar	21EE801	Technical Seminar	EE	One contact hour / week for interaction between the faculty and students				--	100	--	100	01
2	Internship	21INT81	Research Internship/ Industry Internship	EE	Two contact hours / week for interaction between the faculty and students				3 (Batch wise)	100	100	200	15
				TOTAL					**-**	**200**	**100**	**300**	**16**

LIST OF PROFESSIONAL ELECTIVE COURSES

(Student can register for 3 program electives between 5th to 7th semesters from the list given below.			
Group – I		**Group - II**	
Course Code	**Elective Course Title**	**Course Code**	**Elective Course Title**
I. Power Electronics & Drives			
21EEE101	Power Semiconductor Devices	20EEE201	Special Electrical Machines
21EEE102	Switched Mode Power Converter	20EEE202	Solid State Lighting Control
21EEE103	Computer Control of Electrical drives	20EEE203	Power Electronics System Design using ICs
II. Control System			
20EEE111	Fuzzy Logic Control	21EEE211	Programmable Logic Controllers
21EEE112	Artificial Neural Networks	21EEE212	Advanced Instrumentation System
21EEE113	Advanced Control Theory	21EEE213	Industrial Servo Control Systems
21EEE114	Robotics and Automation	21EEE214	Discrete Control Systems
21EEE115	Physiology Control System and Simulation Modelling	21EEE215	Micro- and Nano-Scale Sensors and Transducers
III. Energy System			
21EEE121	Renewable Energy Sources	21EEE221	Illumination Technology
21EEE122	Energy Audit & Demand Side Management	21EEE222	Operation and Maintenance of Solar Electrical Systems
21EEE123	Electrical Power Quality	21EEE223	Electrical Power Utilization
21EEE124	Integration of Distributed Generation Systems	21EEE224	Industrial Heating
21EEE125	Electrical Machines Design	21EEE225	Computer Aided Electrical Drawing
IV. Power System			
21EEE131	HVDC Power Transmission	21EEE231	Flexible AC Transmission Systems
21EEE132	Smart Electric Grid	21EEE232	AI Applications to Power Systems

21EEE133	Modern Power System Protection	21EEE233	Power System Dynamics and Stability
21EEE134	Power System Planning	21EEE234	Reactive Power Management
21EEE135	Power System Operation & Control	21EEE235	Electrical Estimation and Costing
21EEE136	Computer Techniques in Power System	21EEE236	Electro Magnetic Field
V. Microelectronics			
21EEE141	ARM System Architecture	21EEE241	Embedded Systems
21EEE142	Analog and Mixed Signal Layout	21EEE242	Digital Systems Design using HDL
21EEE143	VLSI Circuits and Design	21EEE243	Introduction to ASIC and FPGA Design
VI. IT and Managements			
21EEE151	OOP using C++	21EEE251	Fundamentals of Python Programming
21EEE152	Data structures	21EEE252	Operating System
21EEE153	Total Quality Management	21EEE253	Operations Research
		21EEE254	Introduction to Machine Learning with Python
VII. Electric Vehicles Technologies			
21EEE161	Hybrid Electric Vehicles	21EEE261	Battery storage and Fuel Cells for Electric Vehicles
21EEE162	Hybrid and Plug-in Hybrid Vehicles	21EEE262	Electric Vehicle Battery Charging Methods and Topologies
21EEE163	Power Electronics & Drives for Electric Vehicles	21EEE263	Modeling and Control of Hybrid Electric Vehicles
21EEE164	Automotive Electronics		

OPEN ELECTIVE Courses to be offered from E&EE Department.
21EE8x10 – Non-Conventional Energy Sources
21EE8x79 – Electric Vehicle Technology.

VII Semester

HIGH VOLTAGE ENGINEERING			
Course Code	**21EE701**	**Course Type**	**PCC**
Teaching Hours/Week (L:T:P)	**3:0:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: 21EE104

Course Learning 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: 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 **5 Hours**

Breakdown Phenomena: 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 **10 Hours**

UNIT – II

Generation Of HV AC And DC Voltage: 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 **8 Hours**

Generation of Impulse Voltage and Current: 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. **7 Hours**

UNIT – III

Measurement of High Voltages: 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,

8 Hours

Surge measurement: Klydanograph and magnetic links, Introduction to partial discharges (PD), PD measurement. **2 Hours**

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 insulating 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
21EE701.1	3	3											1	2
21EE701.2	3	3											3	3
21EE701.3	3	3											2	2
21EE701.4	3	3											3	3
21EE701.5	3	3											1	1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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

INDUSTRIAL DRIVES & APPLICATIONS			
Course Code	**21EEE702**	**Course Type**	**PCC**
Teaching Hours/Week (L:T:P)	**2:2:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**25+25**	**Credits**	**03**

Prerequisites: 21EE402, 21EE501, 21EE504

Course Learning 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: 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 **16 Hours**

Selection of motor power rating: Classes of motor duty, Starting and braking of DC shunt and series motor. **3 Hours**

UNIT – II

Control of DC motor DRIVES: 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 **13 Hours**

Induction motor drives: 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 **7 Hours**

UNIT – III

Industrial drives: 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. **9 Hours**

Industrial drives: Rolling mill drives, cement mill drives and paper mill drives

2 Hours

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
21EE702.1	3	3										1	2	3
21EE702.2	3	3										1	1	-
21EE702.3	3	3										1	1	1
21EE702.4	3	3										1	2	3
21EE702.5	3	3										1	3	3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

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

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PROJECT WORK			
Course Code	**21EE703**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**0:0:18**	**SEE Marks**	**0**
Total Hours	**234**	**Credits**	**09**

Teaching Department: Electrical & Electronics Engineering

Course Learning Objectives:

1. To prepare a project proposal based on theoretical understanding of the concepts and literature survey.
2. To conduct a feasibility study of the proposed project work..
3. To arrive at design specifications.

Course Outcomes:

At the end of the course student will be able to

1. Apply theoretical concepts to identify an engineering problem.
2. Review literature to understand the state-of-the-art technologies.
3. Build a team and contribute effectively towards the project.
4. Develop technical writing and presentation skills to communicate effectively.
5. Formulate a project proposal with frozen design specifications to prepare project execution plan.

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
21EE703.1	2	3				2	2	1	2	2	2	3	2	3
21EE703.2	3							2	3	3	2	3	2	3
21EE703.3	2	3			1	1	1	2	3	3	3	1	3	1
21EE703.4	2	1			1			2	3	3	1	3	3	1
21EE703.5	2	2	3		2	1	1	1	3	3	3	3	3	3

1: Low 2: Medium 3: High

VIII Semester

TECHNICAL SEMINAR			
Course Code	**21EE801**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**0:0:2**	**SEE Marks**	**-**
Total Hours	**25**	**Credits**	**01**

Course Learning Objectives:

1. To understand various technological advances happening in the field of electrical and electronics engineering
2. To identify a topic on the advanced electrical and electronics engineering field by extensive literature survey
3. To prepare a document on the selected topic and present in a technical way.

Course Outcomes:

At the end of the course student will be able to

1. Gain knowledge of fast and rapidly changing Electrical and Electronics Engineering by self-learning
2. Identify a topic on the advanced electrical and electronics engineering field after extensive literature survey
3. Write technical documents and give oral presentations on the selected topic using modern tools.
4. Develop the interpersonal skills, presenting skills, soft skills and professional Etiquette.

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
21EE801.1	2	3										2		
21EE801.2	2	3										2		
21EE801.3					1			1		3		1		
21EE801.4					1			1		3		1		

1: Low 2: Medium 3: High

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I. POWER ELECTRONICS & DRIVES

POWER SEMICONDUCTOR DEVICES			
Course Code	**21EEE101**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: Knowledge of Basic Semiconductor devices.

Course Learning Objectives:

6. To understand the principle of operation of power MOSFET and IGBT with their characteristics and effect of reverse recovery transients on switching stresses & losses
7. To study the construction and switching characteristics of various power semiconductor devices
8. To illustrate the importance of gate drive circuits for power devices, design of snubber circuits and heat sinks.

UNIT – I

Introduction: 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 **7 Hours**

Power MOSFET: 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. **8 Hours**

UNIT – II

Power IGBT: 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 **7 Hours**

Power Electronics Devices: Construction and features of - Phase Controlled thyristors, inverter graded thyristors, ASCR, RCT, SUS, SBS, SCS, GTO, MCT, SIT, IGCT, MTO, ETO, PIC. Comparison of power devices. **8 Hours**

UNIT – III

Firing and Protecting Circuits: Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers, Guidance for heat sink selection, heat sink types and design – Mounting types.

10 Hours

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
21EEE101.1	2	2											3	3
21EEE101.2	2	3											1	1
21EEE101.3	2	3											3	3
21EEE101.4	3												2	2
21EEE101.5	2	2	3										2	3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2nd edition,2001.
2. Mohan, Undeland and Robins, "Power Electronics – Converters, applications and Design, John Wiley and Sons, Singapore, 2000.

REFERENCE BOOKS:

3. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
4. B.W Williams 'Power Electronics Circuit Devices and Applications'. Palgrave publishers,1987.

E-Books / MOOC

1. Module 1 of http://www.nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Power%20Electronics/New_index1.html
2. https://www.coursera.org/learn/converter-zircuits/lecture/b5VYY/sect-4-2-0-introduction-to-power-semiconductors

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SWITCHED MODE POWER CONVERTERS			
Course Code	**21EEE102**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:0**	**CIE+SEE Marks**	**50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: Power Electronics (21EE504).

Course Learning 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 switched mode converter topologies: Introduction, generalized comparison between switched mode and linear dc regulator, Control of dc-dc converters, Buck, Boost, Buck-Boost, Cúk dc-dc converter topologies, Full-bridge dc-dc converter.

8 Hours

DC-DC converter with isolation: Flyback converters, other Flyback converter topologies, forward converter, push-pull converter, half and full bridge converter.

7 Hours

UNIT - II

DC-AC switched mode inverters: Basic concept of switch-mode Inverters, single-phase inverter, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, ripple in the inverter output, switch utilization, problems.

8 Hours

Resonant switch converters: Classification of resonant converter, Resonant switch converter – ZCS, ZVS, ZVS-CV dc-dc converters; Resonant dc-link inverter with ZVS, problems.

7 Hours

UNIT - III

Power line disturbances, Power Conditioner, Uninterruptible Power Supplies, solar power based bidirectional inverter.

High frequency inductor and transformers design: specific inductor, transformer design, Inductor and transformer design procedure. **10 Hours**

Course Outcomes:

At the end of the course student will be able to

1. Compare and contrast the Linear Voltage Regulator & SMPC. Describe the working principle of various non-isolated dc-dc converters and design the converter for a given specification
2. Describe the principle of operation of various isolated dc-dc converter and illustrate the design steps to be followed.
3. Analyze various switched mode inverters configurations to calculate performance parameters.
4. Analyze the performance of different resonant converters base on their working principle.
5. Design the magnetic components to be used in switched mode power supply and analyze the role of power conditioners to suppress various power line disturbances.

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
21EEE102.1	2	2	3		1					1*		1	2	3
21EEE102.2	2	2	3		1					1*		1	2	3
21EEE102.3	2	2	3		1					1*		1	1	3
21EEE102.4	2	2	3		1					1*		1	2	2
21EEE102.5	1	2	3							1*		1	3	3

1: Low 2: Medium 3: High

*- If PBL is carried out as a team

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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 /MOOC/ 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

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COMPUTER CONTROL OF ELECTRICAL DRIVES			
Course Code	**21EEE103**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: Power Electronics (21EE504), Industrial Drives and Applications (21EE703).

Course Learning Objectives:

1. Review the applications micro controllers 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 principals 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 MICRO CONTROLLERS IN INDUSTRIAL DRIVES

SYSTEM: Typical Micro controller's 8 bit 16 bit (only block diagram) Digital Data Acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors. **4 Hours**

EVOLUTION OF POWER ELECTRONICS IN DRIVES: Power semiconductors devices used for drives control, Ratings, comparison and their applications. Block diagram of power integrated circuit for DC motor drives. **4 Hours**

AC MACHINE DRIVES: 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.

8 Hours

UNIT – II

SYNCHRONOUS MACHINE DRIVES: 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).

5 Hours

PHASE CONTROLLED CONVERTERS: Converter controls, Linear firing angle control, cosine wave crossing control, phase locked Oscillator principle **2 Hours**

Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, Rectifiers, Current fed Converters. **3 Hours**

PRINCIPALS OF SLIP POWER RECOVERY SCHEMES: Static Kramer's drive system, block schematic 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

5 Hours

UNIT – III

PRINCIPLE OF VECTOR CONTROL OF A C DRIVES: Phasor diagram, digital Implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation.

4 Hours

EXPERT SYSTEM APPLICATION TO DRIVES (ONLY BLOCK DIAGRAM): 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.

5 Hours

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 dives
4. Describe the principals 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
21EEE103.1	2	2												
21EEE103.2	2	3										1		3
21EEE103.3	2	3										1		3
21EEE103.4	2	3										1		
21EEE103.5	2	3			1	1						1	2	3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. "Power Electronics & Motor Drives"-Bimal Bose, Elsevier 2006
2. "Modern Power Electronics & Drives"-Bimal K. Bose, Pearson Education 2003.

REFERENCE BOOKS:

1. "Advanced Microprocessor and Interfacing"- Badri Ram TMH,2001
2. "Microcomputer Control of Power Electronics & Drives" – BK Bose, IEEE press 1987.

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SPECIAL ELECTRICAL MACHINES			
Course Code	**21EEE201**	**Course Type**	**PEC**
Teaching Hours/Week (L: T :P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: DCSM (21EE303), TIM (21EE402).

Course Learning 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: 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. **8 Hours**

Switched Reluctance Motor (SRM): 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.

7 Hours

UNIT – II

Synchronous Reluctance Motor (SyRM): Construction, Working, Control of SyRM, Advantage, Applications. **3 Hours**

PMDC and BLDC Motors: 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 **9 Hours**

Permanent Magnet Synchronous Motor: Construction, principle of operation, Control of PMSM, Applications of PMSM.

3 Hours

UNIT –. III

Single Phase Special Electrical Machines: 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. **5 Hours**

Servo Motors: DC Servo Motors – Construction, Principle of operation, voltage equation, control of DC servo motor. AC Servo Motor – Construction, working, torque speed characteristics.

5 Hours

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
21EEE201.1	2	3												2
21EEE201.2	2	3												2
21EEE201.3	3	2												3
21EEE201.4	2	3												2
21EEE201.5	3													2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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.

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SOLID STATE LIGHTING CONTROL			
Course Code	**21EEE202**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: 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.

7 Hour

Color science: introduction to solid state lighting, construction of solid state lighting source, Details of LEDs, 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 **8 Hours**

UNIT - II

Converters for Lighting: drivers, linear regulator, switch mode regulators using buck, boost and buck boost converter , Adaptive Control Techniques

8 Hours

Light and health: 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.

9 Hours

UNIT - III

Application of Solid-state lighting: Horticulture lighting, Hospital lighting, architectural lighting, commercial lighting, Seasonal Affective disorder, Alzheimer, museum lighting.

8 Hours

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE202.1	2	3												
21EEE202.2	2	3												2
21EEE202.3	2	3												2
21EEE202.4	2	3	3									1	2	
21EEE202.5	2	3				1	2					1		

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Light emitting diodes- Fred Schubert, 2nd Edition, Rensselaer Polytechnic Institute, New York, Cambridge University Press, 2006.
2. LED for lighting Applications, 1st Edition, Patrick Mottier, Wiley, 2009

REFERENCE BOOKS:

1. LED lighting a primer to lighting the future Sal Cangeloso, Maker press, 2012
2. Understanding the LED illumination, M Nisa Khan, CRC Press, 2013.

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POWER ELECTRONICS SYSTEM DESIGN USING ICs			
Course Code	**21EEE203**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE +SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed. **7 Hours**

Switching Regulator Control Circuits: Introduction, isolation techniques of switching regulator systems, PWM systems. **8 Hours**

UNIT – II

Commercial PWM Control ICs and their Applications: 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. **8 Hours**

Switching Power Supply Ancillary, Supervisory & Peripheral Circuits and Components: 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. **8 Hours**

UNIT – III

Programmable Logic Controllers (PLC): Basic configuration of a PLC, Programming and PLC, program modification, power plant control using PLCs. **9 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE203.1	2	3												
21EEE203.2	2	3										1		2
21EEE203.3	3											1		2
21EEE203.4	2	3										1		2
21EEE203.5	2	3										2		

1: Low 2: Medium 3: High

*- If PBL is carried out as a team

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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.
3. UNIT rode application notes: http://www.smps.us/UNIT rode.html

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II. CONTROL SYSTEM

FUZZY LOGIC CONTROL			
Course Code	**21EEE111**	**Course Type**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE +SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: 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. **7 Hours**

Theory of approximate reasoning: Linguistic variables, linguistic hedges, Fuzzy if then statements, inference rules, compositional rule of inference, graphical technique of inference, Fuzzification and defuzzification procedures**.** **8 Hours**

UNIT – II

Development of membership functions-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. **9 Hours**

Fuzzy knowledge-based controllers (FKBC): 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. **8 Hours**

UNIT – III

ADAPTIVE FUZZY CONTROL: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller, Model based controller. **8 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE111.1	3													
21EEE111.2	2	3												
21EEE111.3	1	2	3		2				1	1				3
21EEE111.4	1	2	3	2	2				1	1				2
21EEE111.5	3													

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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 / MOOC/ NPTEL

1. http://nptel.ac.in/courses/108104049/
2. http://videolectures.net/acai05_berthold_fl/

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ARTIFICIAL NEURAL NETWORKS			
Course Code	**21EEE112**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. **7 Hours**

Supervised learning, single layer networks, perceptron's, linear separability, perceptron training algorithm, guarantees of success, modifications. **4 Hours**

Multiclass networks-I, multilevel discrimination, preliminaries, back propagation, setting parameter values, theoretical results. **5 Hours**

UNIT – II

Accelerated learning process in layered neural network, application, mandaline, adaptive multilayer networks. **4 Hours**

Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner take all networks. **4 Hours**

Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, noncognition. **4 Hours**

Associative models, hop field networks, brain state networks, Boltzmann machines, hetero associations. **4 Hours**

UNIT – III

Optimization using hop filed networks, simulated annealing, random search, evolutionary computation. **8 Hours**

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
21EEE112.1	3													
21EEE112.2	2	3												2
21EEE112.3	2	3			2					1				
21EEE112.4	2	3	2		2					1				2
21EEE112.5	3	1			2					1				2

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 DELH, 2010
4. Hertz, Krogh, Palmer, Introduction to theory of neural computation, Addison Wesley, 1991.

E-Books / MOOC

1. http://nptel.ac.in/courses/117105084/
2. http://nptel.ac.in/courses/117108048/module8/Lecture26.pdf
3. http://cse22-iiith.vlabs.ac.in/

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ADVANCED CONTROL THEORY			
Course Code	**21EEE113**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: Linear Control System (20EE503), VCTT (20EE301)

Course Learning 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 behaviour of non-linear system and analyse the phase trajectory
6. To study the Lyapunov stability criteria for nonlinear systems.

UNIT - I

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. **7 Hours**

State transition matrix & its properties, computation using Laplace transformation, Cayley-Hamilton method (only computation), Eigenvalues, Eigen vectors, generalized Eigen vectors, diagonalization. **7 Hours**

UNIT – II

Concept of controllability & observability, methods of determining the same. Pole placement techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement. **8 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 and Delta method. **9 Hours**

UNIT – III

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 and for linear systems for state variable models. **9 Hours**

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
21EEE113.1	2	3			3*									3
21EEE113.2	2	3			3*					2*				
21EEE113.3	3	2		3	3*					2*				2
21EEE113.4	3	2		3	3*					2*				3
21EEE113.5	2	3		2	3*					2*				2

1: Low 2: Medium 3: High

*- if simulations are carried out as a part of PBL component in group

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. J. 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 Books /MOOC/ NPTEL

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

ROBOTICS AND AUTOMATION			
Course Code	**21EEE114**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:

1. To understand the basic of 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: Introduction to robotics, Components and Structure of Robots, robot classification, robot configurations, specifications, Common Kinematic arrangements, Rotations, Composition of Rotations, Properties, Homogeneous Transformation.

8 Hours

Robot sensors: Introduction, desirable features of sensors, magnetic sensors, fibre optic, tactile sensors, proximity and non- proximity sensors. **4 Hours**

Manipulators, Actuators and grippers: Construction of manipulators, types of actuators, grippers, classification, force analysis of gripper mechanism, designing of grippers. **4 Hours**

UNIT – II

Control: Introduction, Actuator dynamics, Set-Point Tracking, Drive Train Dynamics, Trajectory Interpolation, Feed forward Control and Computed Torque. **4 Hours**

Kinematics: Forward, inverse and velocity kinematics Denavit- Hardenberg Representation, Examples **4 Hours**

Dynamics: 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. **7 Hours**

UNIT – III

Robot programming: Lead through programming methods, Robot programming languages-examples. **5 Hours**

Case studies: Robot applications in manufacturing, robot cell design, machine interface, multiple robots, robot in assembly and inspection.

4 Hours

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
21EE114.1	3													
21EE114.2	2	3										1		2
21EE114.3	1	2	3									1		
21EE114.4	2	3										1		3
21EE114.5	2	3										1		

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

REFERENCE BOOKS:

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)
3. Lee, K.S. Fu, R.C. Gonzalez & C.S.G, Robotics, McGraw Hill,2008
4. Bruno Sicilian, Modelling and controlling of Robot manipulations, Springer,2000
5. Saeed B. Niku, Introduction to robotics, PHI,2005
6. Robert J. Schilling, Fundamentals of Robotics Analysis and control, PHI,1996

E-Books / MOOC /NPTEL

1. http://nptel.ac.in/downloads/112101098/
2. http://nptel.ac.in/downloads/112101099/

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PHYSIOLOGY CONTROL SYSTEM AND SIMULATION MODELLING			
Course Code	**21EEE115**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: VCTT, PTNM, Control Systems, Advanced Control Theory

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: -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. **7 Hours**

Regulation in physiological control system: Regulation of electrolyte concentration, acid base balance, red blood cell production, arterial pressure, blood volume, respiration, body temperature, blood glucose.

8 Hours

UNIT – II

Biological control structure and modelling: 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. **8 Hours**

Control and regulation of respiratory system: Modelling of oxygen uptake, mass balance of lungs, gas transport mechanism of lungs, oxygen and carbon dioxide transport in blood and tissue. **7 Hours**

UNIT – III

Application of biological control: Eye tracking control, Pupil control. **5 Hours**

MATLAB Application and simulation: Derivation of Cardiovascular control system theoretical and using matlab . **5 Hours**

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 systems.
5. Develop simple models of the physiological control systems and analyze its 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
21EEE115.1	2													
21EEE115.2	3				3				1	1				
21EEE115.3	2	3			3				1	1				2
21EEE115.4	2	3			3				1	1				2
21EEE115.5	2	3			3				2	1				3

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Bio- Medical Engineering Principles By: David. Cooney, Michel Deckker INC.
2. Biological control systems: John H Milsum McGraw Hill 1966.
3. The Application of Control Theory of a Physiological System by Howard T Milhorn
4. Automatic control systems: By Benjamin C Kuo.
5. Control system Engineering: By I. J .Nagarath.& M. Gopal.

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.

List of experiments for task by simulation

1.	Develop a mathematical model and analyse the response of muscle stretch reflex mechanism for an impulse input.
2.	Develop the simplified model of cardiovascular system and measure the rise time, peak overshoot, settling time and steady state error for the nominal values of L, C and R and compare with the response of diseased person.
3.	Identify the physiological system from the time response analysis for the known input and output conditions.
4.	Frequency response analysis and designing of lag/lead compensator for improving the phase margin, gain margin and bandwidth of the light pupil reflex model. Estimate the rage of K for stability.
5.	Design of controllers (P,PI, PID) for improving time domain specifications of lung mechanics

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PROGRAMMABLE LOGIC CONTROLLERS			
Course Code	**21EEE211**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J-The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: DSD (21EE303)

Course Learning 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: Introduction to Programmable logic controller (PLC), SCADA Fundamentals: Introduction, Open system: Need and advantages, 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).

9 Hours

UNIT – II

Programming: Ladder programming- ladder diagrams, logic functions, latching, multiple

outputs, entering ladder programs, functional blocks, program examples, location of stop and emergency switches. **7 Hours**

Programming Languages: Instruction list, sequential functions charts, structured text

Internal Relays: ladder programs, battery- backed relays, one - shot operation, set and reset, master control relay, example programs, jump and call subroutines**.** **9 Hours**

UNIT – III

Timers and counters: Types of timers, programming timers, OFF- delay timers, pulse timers, programming examples, forms of counter, programming, up and down counting, timers with counters, sequencer. **8 Hours**

Shift register and data handling: shift registers, ladder programs, registers and bits, data handling, arithmetic functions, closed loop control, Structure of control system, Temperature control **7 Hours**

Note: Discussing the programming should be restricted to only one type of PLC (Mitsubhishi)

Course Outcomes:

At the end of the course, the 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 various programming languages to achieve specific control mechanism for a given application
3. Use internal relays of PLC to control peripheral devices
4. Identify timer/counter resources of a PLC to design control logic for interfaced device.
5. Choose special functionalities of PLC to control and monitor functions and design the real-world 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
21EEE211.1	3													
21EEE211.2	1	3			2				1	1				
21EEE211.3	1	2	3		2				1	1		1	2	3
21EEE211.4	1	2	3		2				1	1		2	2	2
21EEE211.5	1	2	3		2				1	1		2	3	3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **1** question from **Unit - I** and **2** full questions each from **Unit – II** and **Unit – III**.

TEXTBOOKS:

1. "Programmable Logic controllers"-W Bolton, 6th edition, Elsevier- newness, 2015.
2. "Programmable logic controllers - principles and applications"-John W Webb, Ronald A Reis, -5th edition, 2nd impression, Pearson education, 2009.

REFERENCE BOOKS:

1. "Programmable Controller Theory and Implementations"-L. A Bryan, E. A Bryan, -2nd edition, 2003..
2. "Programmable Controllers – An Engineers Guide"-E. A Paar, 3rd edition, newness, 2003.

E Books / MOOC/ NPTEL:

1. http://library.automationdirect.com/plc-handbook/
2. https://www.coursera.org/learn/intelligent-machining/lecture/fGz3r/programmable-logic-controllers-plc
3. https://www.udemy.com/plc-programming-from-scratch/
4. http://nptel.ac.in/courses/112102011/
5. http://nptel.ac.in/courses/112103174/

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ADVANCED INSTRUMENTATION SYSTEM			
Course Code	**21EEE212**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: BEE (21EE104), I&M (21EE306)

Course Learning 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: Frequency meter, measurement of time and frequency (mains), tachometer, phase meter, capacitance meter. Automation in digital Instrumentation. **7 Hours**

Analyzer: Wave analyzers and Harmonic distortion, Basic wave analyzer, Frequency selective wave analyzer, Harmonic distortion analyzer and Spectrum analyzer. **8 Hours**

UNIT - II

Measuring Instruments: Output power meters, Field strength meter Vector impedance meter, Q meter applications-Z, Z 0 and Q. Basic LCR bridge, RX meters. **4 Hours**

Measurement of power: Measurement of large amount of RF power (calorimetric method), measurement of power on a transmission line, standing wave ratio measurements. **4 Hours**

Transducers: 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.

8 Hours

UNIT - III

Data acquisition and conversion: Generalized data acquisition system (DAS), Signal conditioning of inputs, single channel DAS, multi-channel DAS, data loggers, compact data logger.

4 Hours

Data transmission: universal serial bus, IEEE-1394.Long distance data transmission (modems), IEEE 488 bus, Electrical interface. **5 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE212.1	3	2												1
21EEE212.2	3	2											1	2
21EEE212.3	3	2												
21EEE212.4	3	2												2
21EEE212.5	3	2											2	2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

REFERENCE BOOKS:

1. Electronic Instrumentation, H S Kalsi, MHE, 3rd Edition, 2010.
2. Modern Electronic Instrumentation and Measuring Techniques, Cooper D and A D Helfrick,PHI,2009
3. Student Reference Manual for Electronic Instrumentation Laboratories, Stanley Wolf, Richard F H, Smith, PHI, 2nd Edition, 2010.

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INDUSTRIAL SERVO CONTROL SYSTEMS			
Course Code	**21EEE213**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J –The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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, 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)

8 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: 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 **8 Hours**

UNIT – II

Generalized Control Theory: 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 **8 Hours**
Performance Criteria: 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

7 Hours

UNIT – III

Machine Considerations: Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque and Friction Considerations, Drive Duty Cycles

9 Hours

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 servosystem 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
20EEE213.1	3													
21EEE213.2	1	3			2				1	1				2
21EEE213.3	1	2	3		2				1	1				2
21EEE213.4	2	3												
21EEE213.5	1	3												1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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

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DISCRETE CONTROL SYSTEM			
Course Code	**21EEE214**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: Linear Control System, Advanced Control Theory

Course Learning 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: Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction
Modelling discrete-time systems by pulse transfer function: Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph. **8 Hours**
Stability analysis of discrete time systems: Jury stability test, Stability analysis using bi-linear transformation
Time response of discrete systems: Transient and steady state responses, Time response parameters of a prototype second order system. **8 Hours**

UNIT – II

Discrete state space model: 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: Controllability and observability, Stability, Lyapunov stability theorem**.** **8 Hours**
State feedback design: Pole placement by state feedback, Set point tracking controller, Full order observer, Reduced order observer.
Deadbeat response design: Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response **7 Hours**

UNIT – III

Illustration of design procedures of sampled data control systems: 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) **9 Hours**

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
21EEE214.1	2	2	3											
21EEE214.2	2	2	3		2				1	1		1		2
21EEE214.3	2	2	3		2				1	1				2
21EEE214.4	2	2	3		2				1	1		1		3
21EEE214.5	2	2	3		2				1	1		1		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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.
3. G. F. Franklin, J. D.Powell and M. L. Workman, Digital Control of Dynamic Systems, Pearson Education 3rd Edition, 2005
4. Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000.
5. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.

E-Books / MOOC

1. NPTEL - Course on Digital Control Systems

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MICRO- AND NANO-SCALE SENSORS AND TRANSDUCERS			
Course Code	**21EEE215**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning Objectives:

1. To explain measurement of pressure using sensors, based 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, and the so-called "Lab-on-a-Chip" 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 Sensors: Capacitive Pressure Sensors, Inductive Pressure Sensors, Ultrahigh Sensitivity Pressure Sensors.

Motion and Acceleration Sensors: Ultrahigh Sensitivity, Wide Dynamic Range Sensors, Other Motion and Acceleration Microsensors.

Gas and Smoke Sensors: A CO Gas Sensor Based on Nanotechnology, Smoke Detectors.

14 Hours

UNIT – II

Moisture Sensors: Structure, Theory, Main Experimental Results, Auxiliary Experimental Results.

Optoelectronic and Photonic Sensors: Optoelectronic Microphone, Other Optoelectronic and Photonic Micro Sensors.

Biological, Chemical, and "Lab on a Chip" Sensors: Lab on a Chip Sensors, Other Biochemical Micro- and Nano-Sensors.

Electric, Magnetic, and RF/Microwave Sensors: Magnetic Field Sensors, Other Important Electromagnetic/RF Micro- and Nano-Sensors. **16 Hours**

UNIT - III

Integrated Sensor/Actuator Units and Special Purpose Sensors: Aircraft Icing Detectors, Other Special Purpose Small-Scale Devices.

10 Hours

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
21EEE215.1	2	3											1	1
21EEE215.2	2	3											1	1
21EEE215.3	2	3											1	1
21EEE215.4	2	3											1	1
21EEE215.5	2	3											1	1

1: Low 2: Medium 3: High

SEE QUESTION PAPER PATTERN:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Micro- and Nano-Scale Sensors and Transducers, Ezzat G. Bakhoum, CRC Press, 2015

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III. ENERGY SYSTEMS

RENEWABLE ENERGY SOURCES			
Course Code	**21EEE121**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: 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. **3 Hours**

Solar Energy Basics: 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. **5 Hours**

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.

4 Hours

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. **4 Hours**

UNIT – II

Energy Storage: Introduction, necessity of energy storage, and methods of energy storage (classification and brief description using block diagram representation only). **4 Hours**

Wind Energy: 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 **4 Hours**

Biomass Energy: 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. **7 Hours**

UNIT – III

Energy from Ocean: 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 **5 Hour**

Emerging Technologies: Fuel cell, small hydro resources, hydrogen energy and wave energy. (principle of energy generation using block diagrams, advantages and limitations). **4 hours**

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
21EEE121.1	3													
21EEE121.2	2	3				2	2	2						2
21EEE121.3	3					2	2							
21EEE121.4	2	3				2	1							2
21EEE121.5	3					2	2							

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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, 2nd Edition, 2009.

REFERENCE BOOKS:

1. Mukherjee D. and Chakrabarti, S., "Fundamentals of Renewable Energy Systems", New Age International Publishers, **5th edition,** 2011.
2. S. P. Sukhatme, J. K. Nayak "Solar Energy: Principles of Thermal Collection and Storage", 3e McGraw-Hill Education (India) (2009).

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ENERGY AUDIT & DEMAND SIDE MANAGEMENT			
Course Code	**21EEE122**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning 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: Energy situation – world and India, energy consumption, conservation. codes, standards and legislation. **5 Hours**

Energy Economic Analysis: The time value of money concept, developing cash flow models, Payback analysis, depreciation, taxes and tax credit –problems. **5 Hours**

Energy Auditing: Introduction, elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results. **5 Hours**

UNIT – II

Electrical System Optimization: The power triangle, motor horsepower, power flow concept, electrical equipment and power factor –correction & location of capacitors. **6 Hours**

Demand Side Management: 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. **10 Hours**

UNIT – III

Energy efficient motors, Lighting basics, Electrical rate tariff: Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.

9 Hours

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
20EEE122.1	2	3					1						1	2
20EEE122.2	2	3				1	1							2
20EEE122.3	2	3					1							2
20EEE122.4	2	3					1							
20EEE122.5	2	3				1	1							2

1: Low 2: Medium 3: Hig1h

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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)

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ELECTRICAL POWER QUALITY			
Course Code	**21EEE123**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: PSAS (21EE601), PE (21EE504)

Course Learning 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: General classes of power quality problems, Transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms

3 Hours

Voltage sags and interruptions: Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, monitoring sags. **5 Hours**

Transients over voltages: 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

8 Hours

UNIT – II

Applied harmonics: Harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics **7 Hours**

Power quality benchmark: 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 **8 Hours**

UNIT – III

Power quality monitoring: Monitoring considerations, power quality measurement equipments, assessment of power quality measurement data, application of intelligent systems and power quality monitoring standards.

9 Hours

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE123.1	2	3												
21EEE123.2	2	3												2
21EEE123.3	3													2
21EEE123.4	2	3												
21EEE123.5	3													2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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	**21EEE124**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: Introduction, status ,properties of wind power, power distribution as a function of wind speed, solar power: status, properties, space requirements, photovoltaic's, 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. **7 Hours**

Distributed Generation (continued): 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.

4 Hours

Overloading and Losses: 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. **4 Hours**

UNIT – II

Over loading and Losses (continued): Increasing the hosting capacity: increasing the loadability building new connections, inter trip schemes, advanced protection schemes, energy management systems. power electronics approach, demand control, prioritizing renewable energy, dynamic loadability.

Voltage Magnitude Variations: 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.

Design of Distribution Feeders: 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.

6 Hours

Voltage Magnitude Variations (continued): 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. **5 Hours**

Power Quality Disturbances: 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.

5 Hours

UNIT – III

Power Quality Disturbances (continued): 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. **9 Hours**

Course Outcomes:

At the end of the course the 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
21EEE124.1	3						1							
21EEE124.2	2	3												2
21EEE124.3	1	2	3											
21EEE124.4	3						1							2
21EEE124.5	1	3												3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Math Bollen, Integration of Distributed Generation in the Power System, Wiley, 2011

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ELECTRICAL MACHINE DESIGN			
Course Code	**21EEE125**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**2*:2:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**26*+26**	**Credits**	**03**

*** Note:** Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites: Electrical Machine-2 (21EE501), Electrical Machine-1 (21EE402)

Course Learning 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
4. To the analyze the design of Three phase Induction Machine

UNIT – I

Principles of electrical machine design:

Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. **3*+0 Hours**

Design of transformers (Single phase and three phase): 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, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular).

7*+10 Hours

UNIT- II

DESIGN OF DC MACHINES: 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. **6*+6 Hours**

DESIGN OF INDUCTION MOTORS: Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, **4*+4 Hours**

UNIT – III

DESIGN OF INDUCTION MOTORS (Contd.)

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, Estimation of no load current and leakage reactance. **6*+6 Hours**

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 transformer for required specification
3. Design the field system of a DC machine for given specification
4. Design the armature of a DC machine for given specification
5. Design a three-induction machine for required 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:													1	2
21EEE125.1	3													
21EEE125.2	2	2	3											3
21EEE125.3	2	2	3											3
21EEE125.4	2	2	3											3
21EEE125.5	2	2	3											3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. A Course in Electrical Machine Design - A.K.Sawhney, Dhanpatt Rai& Sons,7TH EDITION, 2003.
2. Design of Electrical Machines - V. N. Mittle, Standard Publishers distributors ,4th edition,2009.
3. Electrical Engineering Drawing -Bhattacharya, S. K., New age International publishers,2nd edition,2009.
4. Electrical Drafting -Devalapur, S. F., Eastern Book Promoters, Belgaum, 2006.

REFERENCE BOOKS:

1. Performance and Design Of AC Machines - M.G.Say, CBS Publishers and Distributors Pvt. Ltd,3rd edition,2002.
2. Principles of Electrical Machine Design - R.K. Agarwal, SK Kataria and sons, 7th edition,2014.
3. Design Data Handbook - A. Shanmugasundarm, G. Gangadharan, R.Palani, Wiley Eastern Lt.
4. AutoCAD User's Guide, Auto CAD, AutoDesk Inc.

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ILLUMINATION TECHNOLOGY			
Course Code	**21EEE221**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: 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. **8 Hours**

Propagation of light & photometric units: 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. **8 Hours**

UNIT - II

Production of radiation: Sources of radiation-generation-coherent & icoherent 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. **8 Hours**

Artificial light sources: 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.

8 Hours

UNIT – III

Interior Lighting Design: 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.

8 Hours

Light and health: 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.

3 Hours

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
21EEE221.1	2	3												1
21EEE221.2	2	3				1	2							
21EEE221.3	2	3				1	2							
21EEE221.4	2	3				2	2							
21EEE221.5	2	2	3			1	2							2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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	**21EEE222**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning 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: Solar resources, quantifying solar radiation, the effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays.

3 Hours

PV Industry and Technology: 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.

3 Hours

PV Cells, Modules and Arrays: 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

2 Hours

Inverters and Other System Components: 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. **4 Hours**

Mounting Systems: 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 rack mounts, Pole mounts, Sun-tracking systems, Wind loading, Lightning protection **3 Hours**

UNIT – II

Site Assessment: Location of the PV array, Roof specifications, Is the site shade-free?, 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.

3 Hours

Designing Grid-connected PV Systems: 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.

2 Hours

Sizing a PV System: Introduction, Matching voltage specifications, Calculating maximum voltage, Calculating minimum voltage, Calculating the minimum number of modules in a string, Calculating the maximum voltage, Calculating the maximum number of modules in a string, Calculating the minimum voltage, Calculating the minimum 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.

3 Hours

Installing Grid-connected PV Systems: 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.

3 Hours

System Commissioning: Introduction, Final inspection of system installation, Testing, Commissioning, System documentation. **2 Hours**

System Operation and Maintenance: System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, other common problems. **3 Hours**

UNIT – III

Marketing and Economics of Grid-connected PV Systems: 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. **4 Hours**

Case Studies: Case studies A to G **5 Hours**

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
21EEE222.1	3					1	2							
21EEE222.2	3					1	2					1		3
21EEE222.3	3					1						1		
21EEE222.4	3					1						1		
21EEE222.5	2	3				1	1					1		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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
2. Chetan Singh Solanki, Solar Photovoltaics - Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2015

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ELECTRICAL POWER UTILIZATION			
Course Code	**21EEE223**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: Basic Electrical Engineering (21EE104), Sensors and Measurements (20EE405), Electrical machine -2 (21EE501)

Course Learning 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: 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 **9 Hours**

ELECTROLYTIC PROCESS: Fundamental principles, extraction, refining of metals, electroplating. Factors affecting electro deposition process, power supply for electrolytic process. **7 Hours**

UNIT - II

ELECTRIC TRACTION: 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,

8 Hours

AC TRACTION EQUIPMENT: 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. **7 Hours**

UNIT - III

ILLUMINATION: 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 **6 Hours**

INTRODUCTION ELECTRIC AND HYBRID VEHICLES:

Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement, vehicle performance and energy consumption. **3 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE223.1	3													
21EEE223.2	3						2							
21EEE223.3	2	3					2							
21EEE223.4	2	3												2
21EEE223.5	2	3				1	2							

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Utilization Of Electric Energy- E.O. Taylor, Rao V V L, Orient Blackswan Pvt Ltd., New Delhi, 1st Edition
2. Modern Electric, Hybrid Electric and Fuel Cell Vechiles- Mehrdad, Ehsani, Yimin Gao, Sabastien. E. Gay, Ali Emadi- CRC Press,2nd edition,2009
3. Electrical Power by Dr. S.L.Uppal Khanna Publications, 3rd edition, 2009.

REFERENCE BOOKS:

1. A Course in Electrical Power- Soni Gupta and Bhatnager- Dhanapat Rai & sons.2008

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INDUSTRIAL HEATING			
Course Code	**21EEE224**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning 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: Industrial Process Heating Furnaces, Classifications of Furnaces, Elements of Furnace Construction.

Heat Transfer in Industrial Furnaces: 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.

7 Hours

Heating Capacity of Batch Furnaces: 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. **8 Hours**

UNIT – II

Heating Capacity of Continuous Furnaces: 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. **7 Hours**

Saving Energy in Industrial Furnace Systems: 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.

8 Hours

UNIT – III

Operation and Control of Industrial Furnaces: 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.

10 Hours

Course Outcomes:

At the end of the course the 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
21EEE224.1	3													
21EEE224.2	3													
21EEE224.3	3													
21EEE224.4	2	3												2
21EEE224.5	3													2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. W. Trinks, "Industrial Furnaces", Wiley, 6th Edition, 2004.

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COMPUTER AIDED ELECTRICAL DRAWING			
Course Code	**21EEE225**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**1:0:4**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: DCSM (EE303), TIM (EE402), EPGE (405)

Course Learning Objectives:

1. To discuss the terminology of DC and AC armature windings.
2. To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
3. To discuss the substation equipment, their location in a substation and development of a layout for substation.
4. To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
5. To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches

UNIT – I

Introduction to CAD: Study of auto CAD graphics package. Exercises on computer aided electrical drawing - single line diagram for a typical substation.

Winding Diagrams:

(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.
(b) Developed Winding Diagrams of A.C. Machines:
(c)Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.
(d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings.

Single Line Diagrams: Single Line Diagrams of Generating Stations and Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalised Single, Main and Transfer, Double Bus Double Breaker, Sectionalised Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main),Power Transformers, Circuit Breakers, Isolators, Earthing Switches, Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power- Line Carrier) and Line Trap.

15 Hours

UNIT – II

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Transformers - Sectional Views of Single And Three Phase Core And Shell Type Transformers.

7 Hours

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: D.C. Machine - Sectional Views of Yoke with Poles, Armature and Commutator dealt separately.

8 Hours

UNIT – III

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Alternator – Sectional Views of Stator and Rotor dealt separately. **10 Hours**

Course Outcomes:

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

1. Develop armature winding diagram for DC and AC machines
2. Develop a Single Line Diagram of Generating Stations and substation using the standard symbols.
3. Construct sectional views of core and shell types transformers using the design data
4. Construct sectional views of assembled DC AC machine and their parts using the design data or the sketches
5. Construct sectional views of assembled machine and their parts using the design data or the sketches

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
21EEE225.1	2	3			3				1			2		2
21EEE225.2	2	3			3				1			2		2
21EEE225.3	2	3			3				1			2		2
21EEE225.4	2	3			3				1			2		2
21EEE225.5	2	3			3				1			2		2

1: Low 2: Medium 3: High

Semester End Exam:

- The course Semester End Exam will be similar to a Laboratory Course.

TEXTBOOK:

1. A course in Electrical Machine design, A. K. Sawhney, Dhanpat Rai, 6th Edition, 2013
2. Electrical Engineering Drawing, K. L. Narang, Satya Prakashan, 2014

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IV. POWER SYSTEM

HVDC POWER TRANSMISSION			
Course Code	**21EEE131**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: PE (20EE504), T&D (20EE406), PSAS (20EE601)

Course Learning Objectives:

1. To introduce concepts of HVDC and HVAC generation transmission and comparison between them.
2. To choose converter and their control configuration for HVDC power transmission and their configuration.
3. To illustrate the bridge converter under different modes of operation
4. To explain the various methods to Control the HVDC converters.
5. To identify different types of protection used for HVDC system.

UNIT - I

General aspects of DC transmission and comparison of it with Ac transmission: Historical sketch, constitution of EHV AC and DC links, Limitations and Advantages of AC and DC Transmission**.**

8 Hours

Converter circuits: Valve Characteristics, Properties of converter circuits, assumptions, single phase, three phase converters, choice of best circuits for HV DC circuits. **7 Hours**

UNIT - II

Analysis of the bridge converter:- Analysis with grid control but no overlap, Analysis with grid control and with overlap less than 60 deg, Analysis with overlap greater than 60 deg, complete characteristics of rectifier, Inversion. **8 Hours**

Control of HVDC converters and systems: grid control, basic means of control, power reversal, limitations of manual control, constant current versus constant voltage, desired feature of control, actual control characteristics, constant -minimum -Ignition –angle control, constant –current control, constant –extinction –angle control, stability of control.

8 Hours

UNIT - III

Protection: general, DC reactor, voltage oscillations and valve dampers, current oscillations and anode dampers, DC line oscillations and line dampers, clear line faults and reenergizing the line.

9 Hours

Course Outcomes:

At the end of the course student will be able to

1. Compare the HVDC and HVAC transmission systems to list out the advantages and disadvantages.
2. Analyze different converter circuits configuration to select best converter configuration for HVDC power transmission
3. Analyze bridge converter for different modes of operation without and with overlap
4. Apply different techniques for control the HVDC converters
5. Describe different types of protection schemes used in HVDC transmission 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
21EEE131.1	3													
21EEE131.2	2	3												2
21EEE131.3	3	3												1
21EEE131.4	2	3												1
21EEE131.5	3													

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. K.R Padiyar, "HVDC Power Transmission Systems", New Age International Publishers 3/e, 2014.

REFERENCE BOOKS:

1. EW Kimbark, "Direct current Transmission" Wiley-Blackwell; Volume 1 edition, 1971.
2. Prabha Kundur, "Power system stability and control" TMH, 9th reprint, 2007.

E-Books / MOOC /NPTEL

1. http://nptel.ac.in/courses/108104013/

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SMART ELECTRIC GRID			
Course Code	**21EEE132**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning 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's.
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

The Smart Grid: Introduction, Overview of the technologies required for the Smart Grid.
Information and Communication Technologies: Data communication, Switching techniques, Communication channels, layered architecture and protocols Ethernets, Wireless Lan, Bluetooth and Zigbee communication technology **8 Hours**

Information security for the Smart Grid – Introduction, Encryption and decryption, Authentication, Digital signatures, Cyber security standards **4 Hours**
Sensing, Measurement, Control and Automation Technologies: Smart metering - An overview of the hardware used, Communications infrastructure and protocols for smart metering.
4 Hours

UNIT – II

Distribution automation equipment and Management systems – Introduction, Data sources and associated external systems, Modelling and analysis tools,
Transmission system operation - Phasor measurement, Wide area applications. **8 Hours**
Power electronics in Smart Grid – Introduction, Renewable energy generation, Photovoltaic systems, Wind, hydro and tidal energy systems, Fault current limiting. **8 Hours**

UNIT – III

Power Quality Issues in Smart Grid: Power Quality issues, Power Quality Monitoring in smart Grid: Mitigation Methods, EMC Related Phenomena in Smart Electrical Power Systems, Energy Storage Systems **8 Hours**

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's.
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
21EEE132.1	2	3				1								
21EEE132.2	2	3				1						1		2
21EEE132.3	3											1		
21EEE132.4	2	3										1		1
21EEE132.5	2	3				1						1		

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. "Smart Grid - Technology And Applications", Janaka Ekanayake, Kithsiri Liyanage, John Wiley & Sons, Ltd., Publication, 2012

REFERENCE BOOKS:

1. "Power Electronics in Smart Electrical Energy Networks", Ryszard Strzelecki, Grzegorz Benysek, Springer Publication, ISBN-13: 9781848003170, 2008
2. "The Smart Grid: Enabling Energy Efficiency and Demand Response", Clark W. Gellings, P.E, The Fairmont Press, Inc.2009
3. "Smart Grid - Fundamentals of Design and Analysis", James Momoh, 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.

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MODERN POWER SYSTEM PROTECTION			
Course Code	**21EEE133**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: PSAS (20EE601), SGP (20EE602)

Course Learning Objectives:

1. To introduce various static relays used in PS protection.
2. To illustrate the need of Comparators and list out various comparators and their characteristics.
3. To explain the concept of static over current, timer and voltage relays.
4. To illustrate the use and implementation of distance relays.
5. To explain the Principles of Digital/ Numerical Relays

UNIT – I

Static Relays: Introduction, Basic construction, Classification, Basic Circuits, Smoothing Circuits, Voltage regulation, square wave Generator, Time delay Circuits, Level Detectors, Summation device, Sampling Circuits, Zero crossing detector, output devices. **7 Hours**

Comparators: Replica impedance, Mains Transformers, General equation of phase and Amplifiers, Comparators, Realization of ohm, mho, Impedance and offset impedance characteristics, Dualist principal, Static amplifier comparator – Rectifier bridge circulations current type, sampling comparator, static phase comparator accidence circuits type Rectifier phase comparator, Block split comparator, Zen or diode phase comparator

8 Hours

UNIT – II

STATIC OVER CURRENT, TIMER AND VOLTAGE RELAYS:

Instantaneous over current Relay, Definite time lay relay, inverse time over current relay, static timer relay, Basic relay circuits, mono stable delay circuits Single phase Instantaneous over voltage and under voltage relays, instantaneous over voltage relay using Op amp**.**

8 Hours

Distance Relay: general Principal of operation, Zone discrimination, Fault area on impedance diagram, Basic measuring elements, Different characteristics used in distance relaying-Impedance, Reactance, Admittance. Ohm, Distance relay settings, Distance measurement Problems. **8 Hours**

UNIT – III

Principles of Digital/ Numerical Relays: Definition of Numerical Protection System, Advantages of Numerical relays, Block diagram of Numerical Relays, Processing Unit, non-machines Interface, communication in protective relays, Information handling with substation monitoring system.

4 Hours

Digital Relays: Block Schematic approach of microprocessor-based relays, over current relay, Protection Transformer differential protection, Directional relay scheme, Impedance relay scheme.

5 Hours

Course Outcomes:

At the end of the course student will be able to

1. Describe the basic components to understand the construction and working of static relay
2. Apply general equation phase and amplitude comparators to realize the different relay characteristics.
3. Describe static relay circuits for protection against over current, over voltage and under voltages
4. Analyze different distance relays for zone and directional discrimination.
5. Describe the Principle of operation of Digital/ Numerical Relays utilized in various relay protection 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
21EEE133.1	3													
21EEE133.2	2	3												2
21EEE133.3	3												2	
21EEE133.4	2	3												2
21EEE133.5	2	3												2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. T.S. Madava Rao, "Power System protection, Static relays with microprocessor applications", TMH, Second edition, 2004.
2. Wassington A. R. and Van C, "Protective relays and protection" Vol, I & II Chapman and Hell, 1968.

REFERENCE BOOKS:

1. Patra. S.P. Basu. S.K. Chandhri.S. "Power system protection". Oxford, and IBH Publications Co, 1983.
2. Ravindarnath & Chandra "Power System Protection & Switchgear", New age Publications. (GS), 1st edition, 2011.
3. Badriram & Viswa Kharma "Power System Protection & Switchgear", TMH, (GS), 2nd edition, 2013.
4. Y G. Painthankar and S R Bhide, "Fundamentals of power system protection" PHI publication, 2nd edition, 2010.
5. Computer Relaying IEEE Press (Tutorial on Computer Relaying), 1989.

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POWER SYSTEM PLANNING			
Course Code	**21EEE134**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: GTD (21EE503), PSAS (21EE601)

Course Learning 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: 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. **4 Hours**

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 **4 Hours**

Power-System Economics: 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.

4 Hours

Generation Expansion: Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies, Distributed Power Generation, Renovation and Modernisation of Power Plants. **4 Hours**

UNIT – II

Transmission Planning: Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.

4 Hours

Distribution: 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.

6 Hours

Reliability and Quality: 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.

5 Hours

UNIT – III

Demand-Side Planning: Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit.

4 Hours

Electricity Market: 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.

5 Hours

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
21EEE134.1	3	2												
21EEE134.2	2	3												2
21EEE134.3	2	2	3											2
21EEE134.4	3						1							
21EEE134.5	3						2							

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. A. S. Pabla, Electric Power Planning, McGraw Hill, 2nd edition 2016

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POWER SYSTEM OPERATION AND CONTROL			
Course Code	**21EEE135**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: NA (21EE302), GTD (21EE503), PSAS (21EE601), EM2(21EE501)

Course Learning 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 commitment
5. Study the various factors affecting the Power system security and contingency analysis

UNIT – I

CONTROL CENTER OPERATION OF POWER SYSTEMS:
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. **8 Hours**

AUTOMATIC GENERATION CONTROL: 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. **8 Hours**

UNIT – II

CONTROL OF VOLTAGE AND REACTIVE POWER: 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.

8 Hours

UNIT COMMITMENT: Statement of the problem, need and importance of unit commitment, methods-priority lists method, dynamic programming method, constraints, spinning reserve, and examples. **7 Hours**

UNIT – III

POWER SYSTEM SECURITY Factors affecting power system security, power system contingency analysis, detection of network problems, network sensitivity methods, calculation of network sensitivity factor, contingency ranking. **9 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE135.1	3													2
21EEE135.2	2	2	3									1		2
21EEE135.3	2	2	3									1		2
21EEE135.4	2	3												1
21EEE135.5	2	3												1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. "Power generation, operation and control"- Wood & B A J F Woollenberg, John Wiley and Sons, 2nd edition,1996
2. "Electric Power Systems"-B. M. Weedy, Wiley-Blackwell publication, 5th edition, 2012.
3. "Power Systems Operation and Control" – P.S.R.Murthy, 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.

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COMPUTER TECHNIQUES IN POWER SYSTEM ANALYSIS

Course Code:	21EEE136	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: NA (21EE302), GTD (21EE503), PSAS (21EE601), EM2 (21EE501)

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
21EEE136.1	3	3	-	-	3	-	-	-	2	2	-	1	-	2
21EEE136.2	3	3	-	-	3	-	-	-	2	2	-	1	-	2
21EEE136.3	3	3	3	1	3	-	-	-	2	2	-	1	-	2
21EEE136.4	3	3	3		3	-	-	-	2	2	-	1	-	2
21EEE136.5	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

FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)			
Course Code	**21EEE231**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**39**	**Credits**	**03**

J –The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: PE (21EE504), GTD (21EE503), PSAS (21EE601)

Course Learning Objectives:

1. Explain and understand the concept of various FACTS Controllers for power flow control
2. Study the requirement and importance of different High-power Semiconductor devices and VSC for control of power Flow
3. Study the application and control of self and line commutated current source Converters
4. Study the control of shunt compensation by passive and active shunt FACTS controllers for enhancement of power transfer capability and damping of power oscillations.
5. Study the application of series FACTS controllers for controlling / routing the power through the desired transmission paths

UNIT – I

FACTS Concepts and general system configuration: Transmission, interconnection, flow of power in AC system, power flow and dynamic stability consideration, of a transmission interconnection, relative importance of controllable parameters, basic types of FACTs controllers, shunt, series, combined shunt and series connected controllers. **10 Hours**

UNIT – II

POWER SEMICONDUCTOR DEVICES: Types of high power devices, principle of high power device characteristics and requirements, IGBT and GTO devices. **3 Hours**

VOLTAGE SOURCED CONVERTERS: Basic concepts, single phase full wave bridge converter operation, and square wave voltage harmonics for a single-phase bridge 3 phase full wave bridge converter.

4 Hours

SELF AND LINE COMMUTATED CURRENT SOURCE CONVERTER: Basic concepts, 3 phase full wave diode rectifier, thyristor-based converter, current sourced converter with turnoff devices, Current sourced versus voltage source converter. **5 Hours**

SHUNT COMPENSATION: Objectives, Midpoint voltage regulation for line segmentation, End of line voltage support to prevent voltage instability, Improvement of transient stability, power oscillation damping. **3 Hours**

UNIT – III

STATIC SHUNT COMPENSATOR SVC AND STATCOM: Methods of controllable VAR generation,

static VAR compensator, STATCOM, comparison between SVC and STATCOM.

7 Hours

STATIC SERIES COMPENSATORS: Objectives of series compensation; variable impedance type of series compensation, GCSC, TSSC, TCSC. Switching converter type series compensation- SSSC, external control for series reactive compensators, application of static series compensation for improvement of transient stability and power oscillation damping. **8 Hours**

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. Compare various High-power Semiconductor devices and analyze the working of Voltage Soured Converters (VSC) and Current Soured Converters (CSC) for active and reactive power flow control.
3. Design Shunt compensation schemes for the improvement of transient stability and damping of power oscillations
4. Analyze the working of static shunt compensation schemes using SVC and STATCOM for voltage and reactive power control
5. Analyze various series compensation schemes using variable impedance and VSC based series FACTS controllers for controlling / routing the power through the desired transmission paths.

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
21EEE231.1	3													
21EEE231.2	1	3												
21EEE231.3	1	2	3										2	2
21EEE231.4	1	1	2	3	2							2		2
21EEE231.5	1	1	2	3	2							2		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. "Understanding Facts - Concepts and technology of flexible AC Transmission system"- Laszlo Gyugyi and Narain G. Hingorani, Wiley, 2011.
2. "FACTS Controllers in Power Transmission and Distribution" - K.R Padiyar – New Age Publications - 2009

REFERENCE BOOK:

1. "EHV – AC, HVDC Transmission & Distribution Engineering" 3rd edition- Sharma S S K KATARIA & SONS-NEW DELHI, 2013.

E Book / MOOC/NPTEL

1. NPTEL Course on "FACTS DEVICES" by Dr. Avik Bhattacharya, IIT Roorkee

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AI APPLICATIONS TO POWER SYSTEMS			
Course Code	**21EEE232**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: PSAS (21EE601)

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: Definition of AI difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA. **3 Hours**

Fuzzy logic and Hybrid systems: Concept of Fuzzy in Power system, Fuzzy Techniques and Applications in power system. **4 Hours**

Comparison among various Artificial Intelligence Techniques: ANN, Fuzzy, Evolutionary algorithms, Expert systems. Hybrid systems: Fuzzy expert system Hybrid, Neural Network system Hybrid. Application in Power system **4 Hours**

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 **4 Hours**

UNIT – II

AI Techniques for protection systems: Introduction: An expert system for Protective relaying settings, Fuzzy logic for power system protection. Artificial neural network in phase selection.

2 Hours

Artificial Neural network for static security assessment: Introduction to power system security assessment, AI techniques to power system security assessment- Fuzzy techniques, ANN

3 Hours

A supervised ANN for power system security prediction: ANN Architecture, Training set selection, A new prediction performance measure, ANN performance evaluation.

3 Hours

Intelligence systems for demand forecasting: Introduction, stages in building a forecast model, Identifying the model, survey of intelligence system for demand forecasting.

8 Hours

UNIT – III

A practical application and implementation of adaptive techniques using neural networks into auto-reclose protection and system control: Introduction, Auto recloser description: conventional scheme, Adaptive reclose description, neural network description, system simulation, fault records, feature extraction, Neural Network training, Neural Network testing.

9 Hours

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 methods 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
21EEE232.1	3													
21EEE232.2	2	2	3		1							1		1
21EEE232.3	1	3												
21EEE232.4	2	3			1							1		2
21EEE232.5	2	3			1							1		1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Artificial Intelligence Techniques in Power Systems by K. Warwick, Arthur Ekwue, Raj Aggarwal, Institution of Electrical Engineers
2. Intelligent system applications in power engineering: evolutionary programming and neural networks by Loi Lei Lai John Wiley, 1998

REFERENCE BOOKS:

1. Introduction to Artificial Intelligence and Expert System by Dan W Patterson, PHI
2. Artificial intelligence by Elaine Rich, Kevin Knight, McGraw-Hill, 1991.

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POWER SYSTEM DYNAMICS AND STABILITY			
Course Code	**21EEE233**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: PSAS (21EE601), ELECTRICAL MACHINES 2 (21EE501)

Course Learning 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: 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 T_{do}' and T_{do}'' **8 Hours**

Load Modeling: Introduction, Two approaches – Polynomial model and Exponential model. Small Signal Angle Stability: Small signal angle stability with SMIB system, detailed model of SMIB **7 Hours**

UNIT – II

Excitation and Prime Mover Controllers: Introduction, Types of excitation, AVR with and without ESS, TGR, Amplifier PSS, Static exciters. **8 Hours**

Modeling of Prime Movers: Introduction, Three major components, Block diagram, Hydraulic

turbine, Steam turbine. **8 Hours**

UNIT – III

Transient Stability Analysis: Simulation for Transient stability Evaluation, Transient stability controllers. **9 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE233.1	3													3
21EEE233.2	2	3												1
21EEE233.3	3													1
21EEE233.4	3													2
21EEE233.5	2	2	3											2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. "Power System Dynamics, Stability and Control"-Padiyar K.R., BPB Publicatons, 2002.
2. "Power System Stability and Control"- Prabha Kundur. McGraw- Hill Publishing Company, 1ST Edition, 2006

REFERENCE BOOKS:

1. "Dynamics and Control of Large Electric Power Systems"- Marija Ilic; John Zaborszky, , IEEE Press and John Wiley & Sons, Inc.2000
2. "Power System Control and Stability Revised Printing"-Paul M. Anderson and A. A. Fouad, John Wiley & Sons, Inc. 2002
3. "Power System Analysis "- Arthur Bergen, Second Edition. Pearson India 2002

REACTIVE POWER MANAGEMENT			
Course Code	**21EEE234**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: NA (21EE302), GT&D (21EE406), PSAS (21EE601)

Course Learning 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, 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. **9 Hours**

Methods of voltage or Reactive power control: Shunt reactor, Shunt capacitor, Series capacitor, Synchronous condenser, Static VAR system **8 Hours**

UNIT - II

Principles of Transmission system compensation, Effect of Harmonics on reactive power control: Harmonic sources. **8 Hours**

Resonance, Shunt capacitors and Filters, Telephonic Interference. **7 Hours**

UNIT – III

Reactive power coordination: Reactive power management, Transmission benefits, Reactive power dispatch and equipment impact.

9 Hours

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 utilised 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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE234.1	3													
21EEE234.2	2	3												2
21EEE234.3	3													
21EEE234.4	2	3												2
21EEE234.5	3													1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. T.J.E. Miler – 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 Kunder – Power System Stability and Control (TATA McGRAW-HILL),1st edition,2006.
2. IEEE Gude on Harmonic control & Reactive compensation of Power converters – IEEE student 519 – 1981.

E-Books / MOOC / NPTEL

1. http://nptel.ac.in/courses/108101040/20

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ELECTRICAL ESTIMATION AND COSTING			
Course Code	**21EEE235**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning 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: 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 -29,30,45,46,47,50,51,54,55,77 and79.

6 Hours

Wiring: 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 UNIT s, Earthing Conductor.

6 Hours

Internal Wiring: General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the TEXTBOOK), Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout.

4 Hours

UNIT – II

Service Mains: Introduction, Types, Estimation of Underground and Overhead Service Connections. **5 Hours**

Design and Estimation of Power Circuits: 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.

4 Hours

Estimation of Overhead Transmission and Distribution Lines: (Review of Line Supports, Conductor Materials, Size of Conductor for Overhead Transmission Line, Types of Insulators) [No Question Shall be Set From the Review Portion].

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.

6 Hours

UNIT – III

Estimation of Substations: 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.

9 Hours

Course Outcomes:

At the end of the course student will be able to

1. Explain the purpose of estimation and costing.
2. Discuss market survey, estimates, purchase enquiries, preparation of tenders, comparative statements and payment of bills to know about the process of estimation.
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 design of lighting points, total load, sub-circuits and size of conductor of conductor to estimate its cost.
5. Discuss overhead transmission and distribution system and its components to estimate its cost. 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
21EEE235.1	2													
21EEE235.2	2	2					2							1
21EEE235.3	2	2	2				2							1
21EEE235.4	2	2					2							
21EEE235.5	2						2							2

TEXTBOOK:

1. J. B. Gupta, A Course in Electrical Installation Estimating and Costing, Katson Books, 9th Edition, 2012

REFERENCE BOOK:

1. "Electrical Estimation and Electrical Wiring Systems", Raghavendra Rao, Sapna Book House,

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ELECTROMAGNETIC FIELDS

Course Code:	**21EEE236**	**Course Type**	**PEC**
Teaching Hours/Week (L:T: P: J)	**3:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

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 **06 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 **06 Hours**

Electric flux density, Gauss's law and Divergence, Vector operator ∇ and Divergence theorem.

Energy and Potential **06 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 **03 Hours**

Boundary conditions for perfect dielectrics, Capacitance.

Poisson's and Laplace's equations **03 Hours**

Derivation of Poisson's and Laplace's equations.

MOS Amplifiers The steady magnetic field **07 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 **07 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
21EEE236.1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
21EEE236.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
21EEE236.3	2	3	-	-	-	-	-	-	-	-	-	-	-	-
21EEE236.4	2	3	-	-	-	-	-	-	-	-	-	1	3	3
21EEE236.5	2	3	-	-	-	-	-	-	-	-	-	1	2	2

1: Low 2: Medium 3: High

TEXTBOOK:

1. William H. Hayt Jr. and John A. Buck, "Engineering Electromagnetics" Tata McGraw-Hill, 7th edition, 2006.

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/108104099
2. https://nptel.ac.in/courses/108104087

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V. MICROELECTRONICS

ARM SYSTEM ARCHITECTURE			
Course Code	**21EEE141**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: MC (20EE403)

Course Learning 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: 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.

8 Hours

ARM7TDMI assembly instructions and modes: 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.

8 Hours

UNIT - II

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.

8 Hours

Cache and Memory Management and Protection: 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).

8 Hours

UNIT – III

ARM tools and peripherals ARM development environment, 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.

9 Hours

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 visualise 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
21EEE141.1	2	3												
21EEE141.2	2	3										1		1
21EEE141.3	2	3										2		2
21EEE141.4	2	3										2		
21EEE141.5	2	3										2		1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. ARM System Developer's Guide : Designing and Optimizing System Software (English) 1st Edition, Andrew Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann Publishers 2011

REFERENCE BOOKS:

1. Arm System-on-chip Architecture, 2nd Edition, Steve Furber, Pearson publication, 2013
2. Arm Assembly Language, Fundamentals and Techniques, 2nd edition, William Hohl, Christppher Hinds, CRC Press, 2014
3. ARM Assembly Language Programming & Architecture By. Muhammad Ali Mazidi, Kindle edition
4. Operating Systems, 5th Edition, By William Stallings
5. Manuals and Technical Documents from the ARM Inc, web site.

E Books / MOOC / NPTEL

1. http://electro.fisica.unlp.edu.ar/arq/downloads/Papers/ARM/Addison%20Wesley%20-%20ARM%20System-on-Chip%20Architecture,%202Ed.pdf
2. http://eee.guc.edu.eg/Courses/Electronics/ELCT912%20Advanced%20Embedded%20Systems/Lectures/ARM%20System%20Developer%27s%20Guide.pdf

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ANALOG AND MIXED SIGNAL LAYOUT			
Course Code	**21EEE142**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: VLSI Circuits & Design (20EE604)

Course Learning Objectives:

1. To understand CMOS process and its construction
2. To introduce various types of matching and mismatches
3. To illustrate floor-planning and power routing
4. To introduce sensitivity, reliability & failure mechanism
5. To comprehend ESD & types of packaging

UNIT – I

CMOS Process Overview: Silicon deposition**,** Photolithography, Diffusion/Ion Implantation, Metalization, Formation of devices
Device Construction: PMOS, NMOS, Drain extended MOS**,** Diodes, Bipolars, Resistors, Capacitors
Matching: Matching and Mismatches in detail, Types of Matching and its usage, Resistor Matching, Capacitor matching
Isolation: Need for isolation: Noise in substrate, Guardring /Substrate connections, Integration of analog and digital blocks **15 Hours**

UNIT – II

Floor-planning: Area Estimation, Module level (Understanding Hierarchy features), Block Level. Bbox concept, UNIT / Half cell concept, Pin Placement
Power Routing: Planning Power, Power to Devices, Star connection
Sensitivity: Shielding sensitive signals, routing clk /high frequency signals, DBKs
Reliability and Failure mechanism: Electromigration, Antenna effect, Latch up, Density.
15 Hours

UNIT – III

ESD Care-abouts: I/O cells ESD event, CDM Clamp
Packaging: Types of packaging, BGA, FLIP CHIP, WCSP **10 Hours**

Course Outcomes:

At the end of the course student will be able to

1. Describe the CMOS process overview to elicit device construction
2. Identify the device matching and isolation with respect to CMOS devices
3. Apply floor planning and power routing to design analog CMOS devices
4. Identify sensitivity, reliability and failure mechanism to erudite electro-migration, antenna effect, and latch up, density issues in CMOS.
5. Describe the ESD and packaging details to comprehend application of CMOS

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
21EEE143.1	3													
21EEE143.2	2	3												1
21EEE143.3	2	3										1		2
21EEE143.4	2	3										1		
21EEE143.5	3											1		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. "The Art of Analog layout", Alan Hastings, Pearson; 2nd edition, 2004

REFERENCE BOOKS:

1. "Introduction to Analog VLSI Design Automation", Ismail Franca, Springer, 2011.
2. "VLSI Design Techniques for Analog", Randall Geiger, Noel Strader, Phillip Allen, 1st Edition, Mcgraw Hill Education, 2010
3. "Analog and Mixed Mode VLSI Design", Gejji V.P, Prentice Hall India Learning Private Limited 2011
4. "CMOS : Circuit Design, Layout And Simulation" , R. Jacob Baker, Wiley, 2009

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VLSI CIRCUITS AND DESIGN			
Course Code	**21EEE143**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Prerequisites: LD (20EE305), AEC(20EE304)

Course Learning 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

CMOS Processing: Introduction to IC Technology, Moore's law, VLSI design flow, VLSI 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, twin tub process, BiCmos **7 Hours**

MOS TRANSISTORS (Electrical Characteristics) : Two terminal MOS structure, flat band voltage, MOS system under external bias, structure and operation of MOS transistors, threshold voltage, drain to source current I_{ds} verses V_{ds} relationships, body effect ,channel length modulation, mobility variation, Tunneling, punch through, hot electron effect MOS, models, small signal AC Characteristics

8 Hours

UNIT – II

Design: Mask Layer, Stick Diagram, Symbolic diagram, Sheet resistance, capacitance layer, inverter delays, rise time, fall time, cascading and super buffer. RC delay model, Linear Delay Model, Logical effort, Parasitic Delay, Design Rules

4 Hours

Scaling: 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

4 Hours

Application-MOS Inverters Static Characteristics: 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 (enhancement, depletion) characteristics, CMOS inverter static characteristics(excluding derivation) design of CMOS inverter, latch up bulk CMOS **8 Hours**

UNIT – III

Application- 2 input NOR and NAND gates: 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.

8 Hours

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
21EEE143.1	3													
21EEE143.2	2	3			1							1		1
21EEE143.3	2	3			1							1		3
21EEE143.4	2	3			1							1		2
21EEE143.5	3											1		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. CMOS Integrated Circuit Analysis And Design by Sang Mo Kang, Usuf Leblebici,3rd Edition, TATA Mc Graw hill edition,2002.
2. Basic VLSI Design by Douglass A Pucknell, Amran Esharaghian, 3rd edition, PHI Publication,2009.
3. CMOS VLSI Design by Neil Weste, David Harris, 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 / MOOC

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

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EMBEDDED SYSTEMS			
Course Code	**21EEE241**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.
Prerequisites: LD(20EE305), MC (20EE403)

Course Learning 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: Embedded systems overview-design challenge-optimizing metrics-processor technology-IC technology- design technology- automation- synthesis- verification: hardware /software co-simulation, trade-offs. **8 Hours**

Processing Elements: 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. **8 Hours**

UNIT – II

Memory: Introduction-memory write-ability and storage permanence, common memory types-composing memory-memory hierarchy and caches-advanced RAM. **7 Hours**

Interfacing: 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. **9 Hours**

UNIT – III

Introduction to Real-Time Operating Systems: 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 **9 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE241.1	3													
21EEE241.2	2	3										1		1
21EEE241.3	2	3										1		2
21EEE241.4	2	3										1		2
21EEE241.5	2	3			1							1		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Frank Vahid and Tony Givargis, Embedded system design: A unified hardware/Software introduction, Third edition, John Wiley & sons, 2010
2. Embedded System Premier, David E Simon, Addison Wesley

REFERENCE BOOKS:

1. Embedded System 2nd Edition by Raj Kamal , Tata 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

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DIGITAL SYSTEMS DESIGN USING VERILOG			
Course Code	**21EEE242**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**2:0:2**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: LD (20EE305)

Course Learning Objectives:

This course will enable students to:

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: Evolution of CAD, emergence of HDLs, typical HDL-flow, why Verilog HDL, Trends in HDLs. Introduction to Verilog: Lexical Tokens ,Verilog operators and modules. Verilog ports, datatypes and assignments. Basic Gate level modelling.

10 Hours

UNIT – II

Basics of Gate level Modeling: 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:** Basics of dataflow modelling ,Continuous assignments, concatenation, delay specification, expressions, operators, operands, operator types. Verilog modelling of Combination circuits.

15 Hours

UNIT – III

Behavioral Modeling: 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. **15 Hours**

Course Outcomes:

At the end of the course student will be able to

1. Learn different Verilog HDL constructs.
2. Familiarize the different levels of 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
21EEE242.1	2	3												1
21EEE242.2	2	3			2							1		2
21EEE242.3	2	3			2							1		1
21EEE242.4	2	3			2							1		1
21EEE242.5	2	3			2							1		2

1: Low 2: Medium 3: High

Semester End Exam:

• The course Semester End Exam will be similar to a Laboratory Course.

TEXTBOOK:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
2. Nazeih Botros, " Hdl Programming VHDL and Verilog", Dreamtech Press

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.

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INTRODUCTION TO ASIC AND FPGA DESIGN			
Course Code	**21EEE243**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: 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 **8 Hours**

ASIC PHYSICAL DESIGN: 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 **8 Hours**

UNIT – II

LOGIC SYNTHESIS, SIMULATION AND TESTING: 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. **8 Hours**

FPGA: 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. **8 Hours**

UNIT – III

SOC DESIGN: 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. **8 Hours**

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE243.1	3													
21EEE243.2	1	3			1							1		1
21EEE243.3	1	3			2							1		1
21EEE243.4	2	2	1	3	2							2		1
21EEE243.5	2	3			1							1		1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

REFERENCE BOOKS:

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.
3. John V.Oldfield, Richard C Dore, Field Programmable Gate Arrays, Wiley Publications1995.
4. P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, PrenticeHall, 1994.
5. Parag.K.Lala, Digital System Design using Programmable Logic Devices , BSP, 2003.

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VI. IT & MANAGEMENT COURSES

OBJECT ORIENTED PROGRAMMING USING C++			
Course Code	**21EEE151**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: Programming for Problem Solving (21CS111)

Course Learning 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: Review of Procedure Oriented Programming, Basic concepts of Object Oriented Programming – Object, Class, Encapsulation, Inheritance, Polymorphism; Benefits of OOPs, Applications of OOP's. **3 Hours**

The Basic Language C++: 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, boole, enumeration, array, complex number; typedef names, type compatibility, type conversion, qualifier – const, volatile; Operators in C++, Operator Precedence; C++ expressions – New and Delete.

5 Hours

Functions in C++: Introduction, The main() function, Function prototype, Call by reference, Return by reference, Inline functions, Default arguments, const Arguments, Function Overloading

3 Hours

Classes: 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. **4 Hours**

UNIT – II

Objects: 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.

4 Hours

Constructors and Destructors: 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.

4 Hours

Operator Overloading and Type Conversion: 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. **5 Hours**

Inheritance: Introduction, Defining derived classes, Single inheritance, Making a private member Inheritable, Multilevel inheritance, Multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes. **3 Hours**

UNIT – III

Pointer, Virtual Functions and Polymorphism: Introduction, Pointers, Pointers to Objects, this pointer, Pointers to derived classes, type-checking pointers, pointers to members, Virtual functions, Pure virtual functions. **4 Hours**

Managing Console I/O and File I/O: 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).

4 Hours

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
21EEE151.1	3													
21EEE151.2	2	3			2									1
21EEE151.3	2	3			2							1		
21EEE151.4	2	3			2							2		1
21EEE151.5	2	3			2							2		1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Object Oriented Programming with C++- Balagurusamy, E, TMH,6th th edition, 2013.
2. C++, The Complete Reference -Herbert Schildt, , TMH, 4th edition ,2002
3. Object Oriented Programming with C++, Farrell, Cengage Learning, Fourth Edition, 2009.

REFERENCE BOOKS:

1. The C++ programming language, Bjarne Stroustrup, Pearson Education, 4th edition, 2013.
2. Objected oriented programming with C++, Bhave, Pearson Education, First Edition, 2012.

E-Books / MOOC /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/

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DATA STRUCTURE			
Course Code	**21EEE152**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning Objectives:

1. To understand the design, analysis of algorithms, Basic data types and trees with reference to data structure.
2. To Illustrate the basic operation on sets and representation of directed graphs
3. To expound the sorting procedure and understand the Algorithm analysis Techniques.
4. To Comprehend the Algorithm Design Techniques.
5. To Demonstrate the use of Data structures and Algorithm for external storage

UNIT – I

Design and Analysis of Algorithms: From problems to programs, Data Structures and Abstract Data types. **3 Hours**

Basic Data Type and Trees: Data types List, Implementation of lists, stacks Queues, Mappings, Stacks and recursive procedures. Basic terminology, ADT Tree, Implementation of trees, Binary trees. **5 Hours**

Basic Operation on Sets: Introduction to sets an ADT with union intersection and difference, A Bit-vector implantation sets, A linked list implementation sets, The dictionary, simple dictionary implementation, the Hash table data structures, Estimating the efficiency of functions,

Implementation of the mapping ADT, Priority Queues, Implementation of priority queues

5 Hours

Directed Graphs: Basic Definitions, Representation for directed graphs, the single source short path problems, Traversals of Directed Graphs, Directed A cyclic graphs, strong components.

4 Hours

UNIT – II

Sorting: The internal sorting model, simple sorting schemes, Quick sort Heapsort, Binsorting. Algorithm analysis Techniques: Efficiency of algorithms, analysis of receive programs solving Recurrence Equations, A general solution for a large class of Recurrences. **7 Hours**

Algorithm Design Techniques: Divide and conquer algorithms, Dynamic programming, Greedy Algorithms, Back tracking, local search algorithms. **7 Hours**

UNIT – III

Data structures and Algorithm for external storage: A model of external computation, External sorting, sorting information in files, external search Trees. **9 Hours**

Course Outcomes:

At the end of the course student will be able to

1. Analyse algorithms to implement various basic data types and trees.
2. Apply basic operations on sets and representation of directed graphs to build trees for database queries.
3. Analyse the various sorting techniques.
4. Develop and implement various algorithm design techniques
5. Demonstrate the use of Data structures and Algorithms for external storage.

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
21EEE152.1	1	2										1		
21EEE152.2	1	2										1		
21EEE152.3	2	3			2							2		1
21EEE152.4	2	2	1		2							2		2
21EEE152.5	2	2	1		2							2		2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Data Structures and Algorithms, Alfred Aho, John E. Hopcroft and Jeffery D Ullaman, Pearson Education 1st edition (2002)

REFERENCE BOOKS:

1. Introduction to Data structures and Algorithms with C+ by Gleen. W.Rowe, PHI Publications.1997,
2. Data structures using C & C++, Langsam, Angenstein, Tenenbaum , Pearson, 2nd edition,2009.
3. Data Structures and Algorithm Analysis in C, Weiss Mark Allen, Pearson Education,3rd Edition,2007.

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TOTAL QUALITY MANAGEMENT			
Course Code	**21EEE153**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

1. Understand the meaning of quality and the development of quality terminology and explain the principles of TQM.
2. Compute mean, median, mode and standard deviation and calculate area under the normal distribution and relate it to the quality concept.
3. Compute control limits for a variable chart and draw the X bar and R chart limits for attribute chart and draw p, np, c and u charts.
4. Explain the Acceptance Sampling plans and understand the concept of Design of Experiments

UNIT – I

Introduction: The Meaning of Quality and Quality Improvement; Statistical Methods for Quality Control and Improvement;

TOTAL Quality Management: Definition, Principles of TQM, Gurus of TQM, Benefits of TQM.

Principles of TQM: Leadership - Deming's philosophy, Customers' satisfaction - Customers perception, Feedback, Employee involvement - quality circles, Continuous Improvement- Juran's Trilogy, PDSA cycle, Kaizen, Six sigma, ISO-9000, ISO-14000, ISO-18000 series of standards.

Modeling Process Quality: Mean, Median, Mode, Standard deviation, calculating area, Normal distribution tables, Finding the Z score, Central limit theorem, 7 QC tools.

Methods and Philosophy of Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on

control charts, warning limits, Average Run Length**-**ARL). **15 Hours**

UNIT – II

Control Charts for Variables: Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. 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.

Control Charts for Attributes: Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit. Numerical problems. **15 Hours**

UNIT – III

Lot-By-Lot Acceptance Sampling for Attributes: The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Numerical problems.

Introduction to Design of Experiments: Hypothesis testing, one sample t-test, orthogonal design of experiments, two factor experimental design, numerical problems on the above topics. **10 Hours**

Course Outcomes (CO):

At the end of the course the student will be able to

1. Understand the concept of quality and evolution of quality concepts over the years
2. Apply statistical concepts for solving simple quality problems.
3. Draw and analyze control charts for variables.
4. Understand the basic concepts of Acceptance Sampling and Design of experiments.
5. Draw and analyze the control chart for attributes

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
21EEE153.1	1					1		1			3			
21EEE153.2	2					2		1			3	1		1
21EEE153.3	1					1					3	2		
21EEE153.4	1					1		1			3			2
21EEE153.5	1					2		1			3	2		

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS :

1. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher, 2004.
2. **Statistical Quality Control:** RC Gupta, Khanna Publishers, New Delhi, 3rd edition, 2005.
3. **Total Quality Management:** Dale H. Besterfield, Pearson Education, 3rd edition, 2011.

REFERENCE BOOKS :

1. **Statistical Process Control and Quality Improvement:** Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
2. **Statistical Quality Control for Manufacturing Managers:** W S Messina, Wiley & Sons, Inc. New York, 1987
3. **Statistical Quality Control:** Montgomery, Douglas, 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ (ISBN 0-471-65631-3).
4. **Principles of Quality Control:** Jerry Banks, Wiley & Sons, Inc. New York.
5. **Design and Analysis of Experiments:** R. Pannerselvam, PHI Learning Private Limited, New Delhi., 2012.
6. **NPTEL course material on Design of Experiments.**

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FUNDAMENTALS OF PYTHON PROGRAMMING			
Course Code	**21EEE251**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: Software, Development Tools, Learning Programming with Python, Writing a Python Program, The Python Interactive Shell

Data, Expressions, Statements: 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; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points

Control Flow, Functions: 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;

15 Hours

UNIT – II

Strings: Strings: string slices, immutability, string functions and methods, string module; Lists as arrays

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; **Tuples:** tuple assignment, tuple as return value;

Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram

Illustrative programs: square root, GCD, exponentiation, sum an array of numbers, linear search, binary search **15 Hours**

UNIT - III

Python Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors , Inheritance , overlapping and overloading operators , Adding and retrieving dynamic attributes of classes. **10 Hours**

Course Outcomes:

The students should 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
21EEE251.1	2	3												
21EEE251.2	2	3			3							1		1
21EEE251.3	2	3			3							1		2
21EEE251.4	2	3			3							1		2
21EEE251.5	2	3			3							1		3

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

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 R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf)
4. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2ndEdition, Green Tea Press, 2015.

REFERENCE BOOKS:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rd Edition,Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176.
5. Reema Thareja, "Python Programming using problem solving approach", Oxford university press, 2017

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OPERATING SYSTEM			
Course Code	**21EEE252**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Course Learning Objectives:

1. To introduce the operating systems concepts.
2. To explain the concepts of structure in operating systems
3. To discuss 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 example of UNIX.

UNIT – I

Introduction and Overview Of Operating Systems: 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, Multi

programming systems, Time sharing systems, Real time operating systems, distributed operating systems. **8 Hours**

Structure of the Operating Systems: Operation of an O.S, Structure of the supervisor, Configuring and installing of the supervisor, Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel based operating systems, and Microkernel based operating systems. **8 Hours**

UNIT – II

Process Management: Process concept, Programmer view of processes, OS view of processes, Interacting processes, Threads, Processes in UNIX, Threads in Solaris. **7 Hours**

Memory Management: Memory allocation to programs, Memory allocation preliminaries, Contiguous and non-contiguous allocation to programs, Memory allocation for program controlled data, kernel memory allocation. **8 Hours**

UNIT – III

Virtual Memory: 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. **9 Hours**

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. Analyse the concept of process management, processes and threads.
4. Illustrate memory allocation and management in operating systems.
5. Analyse 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
21EEE252.1	3													
21EEE252.2	3											1		
21EEE252.3	2	3			2							1		1
21EEE252.4	2	3			2							1		1
21EEE252.5	2	3			3							1		1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. D.M. Dhamdhare, "Operating Systems A Concept Based Approach" Mcgraw Hill Higher Education, 2nd Ed, 2007.
2. Operating System Principles – Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Wiley, 8th Edition, 2009.

REFERENCE BOOKS:

1. Silberschatz and Galvin, "Operating Systems Concepts", John Wiley, 5th Edition, 2001.
2. Operating Systems: A Concept Based Approach – D.M Dhamdhere, TMH, 2nd Edition,2006.
3. Operating Systems, P.C.P. Bhatt, PHI, 2nd Edition, 2008.
4. Operating Systems,Harvey M Deital,Pearson Education, 3rd Edition.
5. Silberschatz and Galvin, "Operating Systems Concepts", John Wiley, 5th Edition, 2001.

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OPERATIONS RESEARCH			
Course Code	**20EEE253**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: PTNM (21EE403),

Course Learning Objectives:

1. To understand the model and obtain solution to the Linear Programming Problems.
2. To Solve the dual of LPP and compare the results of dual and primal. Also apply replacement theory for efficient operations.
3. To Solve transportation and assignment problems and to solve game theory problems
4. Build the network and crash it effectively and efficiently using PERT / CPM methods.

UNIT – I

Introduction: definition, OR models, characteristics and phases of OR. **2 Hours**

Linear programming and Graphic Solution: Linear Programming: Formulation of Two variable LPP model, Graphical solution of two variables LPP, special cases in graphic solution: multiple optimal solution, infeasibility and unboundedness, simplex method: conditions and solutions to LPP using Simplex method, Big M method, Special cases in simplex method: multiple optimal, infeasibility, unboundedness, Degeneracy, sensitivity analysis. **7 Hours**

Duality: Definition of the dual problem, primal to dual relationships, economic interpretation of duality. **3 Hours**

Replacement Theory: Introduction, Replacement policy for equipment which deteriorates gradually, replacement of items that fail suddenly, staff replacement. **5 Hours**

UNIT – II

Transportation Model: definition of transportation model, basic Feasible solution by NW Corner method, Least Cost method and MODI method, optimal solutions: stepping stone method, MODI method, the assignment model, traveling salesman problem.

8 Hours

GAME THEORY: Formulation of two - person, zero sum games, solving simple games, the Max-min min-max principles, graphical solution procedure, solving by linear programming.

8 Hours

UNIT – III

PERT & CPM TECHNIQUES: Network representation, critical path computation, construction of the time schedule, variation under probabilistic models, crashing of simple networks, PERT calculations. **9 Hours**

Course Outcomes:

At the end of the course student will be able to

1. Articulate a problem statement to determine solution to the Linear Programming Problems.
2. Apply replacement theory to find optimal replacement schedule.
3. Design and solve transportation problems to develop an optimal transportation solution
4. Formulate and solve game theory problems to propose the best solution
5. Design and Solve network problems using PERT / CPM methods to develop optimal strategy.

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
21EEE253.1	2	3									1			
21EEE253.2	1	3									1			
21EEE253.3	2	3									1			1
21EEE253.4	1	3									1			1
21EEE253.5	1	3									1			1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. "Quantitative Techniques in Management"- N.D. Vohra Tata McGraw Hill Publications, 4th Edition, 2009.
2. "Operation Research An Introduction"-Hamdy A Taha, Pearson Education, 9th edition, 2012

REFERENCE BOOK:

1. Engineering Optimization: Theory and Practice / Edition 4, by S. S. Rao, Wiley (2009)

E Books/ MOOC/ NPTEL

1. https://www.doc.ic.ac.uk/~br/berc/linearprog.pdf
2. https://www.coursera.org/learn/wharton-operations
3. http://nptel.ac.in/courses/112106134/
4. http://nptel.ac.in/courses/112106131/
5. https://onlinecourses.nptel.ac.in/noc17_mg10/preview

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INTRODUCTION TO MACHINE LEARNING WITH PYTHON			
Course Code	**21EEE254**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Pre-requisite:

Engineering Mathematics I, Engineering Mathematics II, 20EE301-Vector Calculus and Transform techniques, 20EE401-Probability and Numerical Methods, and 20EEE251-Fundamentals of Python Programming

Course Learning 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: Introduction to Machine Learning, Python for Machine Learning, Supervised vs Unsupervised.

Regression: 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.

15 Hours

UNIT- II

Classification: 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). **15 Hours**

UNIT-III

Clustering: Introduction, Introduction to k-Means, Introduction to Hierarchical Clustering, DBSCAN

Recommender Systems: Introduction, Content-based Recommender Systems, Collaborative Filtering. **10 Hours**

Course Outcomes:

The students should 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
21EEE251.1	2	3												
21EEE251.2	2	3			3							1		1
21EEE251.3	2	3			3							1		2
21EEE251.4	2	3			3							1		2
21EEE251.5	2	3			3							1		1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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.
3. A. C. Müller and S. Guido, Introduction to Machine Learning with Python A Guide for Data Scientists, 1st ed. O'Reilly Media, Inc., 2016
4. 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.

VII. ELECTRIC VEHICLES TECHNOLOGIES

HYBRID ELECTRIC VEHICLES			
Course Code	**21EEE161**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: Configurations of electric vehicles (EVs), Performance of EVs, Tractive Effort in Normal Driving, Energy Consumption. EV Policies & Standards

Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains

Design Principle of Series (Electrical Coupling) Hybrid Electric Drive Train: Operation Patterns, Control Strategies, Design Principles of a Series (Electrical Coupling) Hybrid Drive Train, Design Example **15 Hours**

UNIT – II

Parallel (Mechanically Coupled) Hybrid Electric Drive Train Design: Drive Train Configuration and Design Objectives, Control Strategies, Parametric Design of a Drive Train

Design and Control Methodology of Series–Parallel (Torque and Speed Coupling) Hybrid Drive Train: Drive Train Configuration, Drive Train Control Methodology, Drive Train Parameters Design

Design and Control Principles of Plug-In Hybrid Electric Vehicles: Statistics of Daily Driving Distance, Energy Management Strategy, Energy Storage Design.

15 Hours

UNIT – III

Regenerative Breaking: Fundamental of regenerative, Braking Energy Consumed in Urban Driving, Braking Energy versus Vehicle Speed, Braking Energy versus Braking Power, Braking Power versus Vehicle Speed, Braking Energy versus Vehicle Deceleration Rate, Braking Energy on

Front and Rear Axles, Brake System of EV and HEV.

5 Hours

CAN Communication: CAN Fundamentals, CAN message frames, Typical Automotive Networks, **Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies. **5 Hours**

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
21EEE161.1	3													
21EEE161.2	2	3												2
21EEE161.3	2	3												2
21EEE161.4	2	3												2
21EEE161.5	3													1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press, 2010.

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HYBRID AND PLUG-IN HYBRID VEHICLES			
Course Code	**21EEE162**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:

1. To study fundamentals of Hybrid Electric Vehicles (HEV)and EV powertrain component sizing.
2. To understand advanced HEV architectures and dynamics of HEV powertrain
3. To understand plug-in hybrid electric vehicles architecture, power management and component sizing.
4. To introduce special hybrid vehicles

UNIT – I

HEV Fundamentals - Introduction, Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics
Advanced HEV Architectures and Dynamics of HEV Powertrain - Principle of Planetary Gears, Toyota Prius and Ford Escape Hybrid Powertrain, GM Two-Mode Hybrid Transmission, Dual-Clutch Hybrid Transmissions, Hybrid Transmission Proposed by Zhang *et al*. Renault IVT Hybrid Transmission, Timken Two-Mode Hybrid Transmission, Tsai's Hybrid Transmission, Hybrid Transmission with Both Speed and Torque Coupling Mechanism, Toyota Highlander and Lexus Hybrid, E-Four-Wheel Drive, CAMRY Hybrid, Chevy Volt Powertrain, Dynamics of Planetary-Based Transmissions

15 Hours

UNIT – II

Plug-in Hybrid Electric Vehicles -Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs, Vehicle-to-Grid Technology **15 Hours**

UNIT – III

Special Hybrid Vehicles - Hydraulic Hybrid Vehicles, Off-road HEVs, Diesel HEVs, Electric or Hybrid Ships, Aircraft, Locomotives, Other Industrial Utility Application Vehicles, HEV Applications for Military Vehicles

10 Hours

Course Outcomes:

At the end of the course student will be able to

1. Describe the fundamentals of HEV and planetary gears to estimate EV powertrain component sizing
2. Analyze advanced HEV architectures and speed - torque coupling mechanism to understand hybrid transmissions of different manufacturers.
3. Describe the architecture of plug-in hybrid electric vehicles to understand power management.
4. Analyze the component sizing and concept of vehicle-grid technology.
5. Compare and contrast various special hybrid vehicles.

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
21EEE162.1	3													2
21EEE162.2	2	3												2
21EEE162.3	2	3												
21EEE162.4	2	3												2
21EEE162.5	2	3												

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Hybrid Electric Vehicles-Principles and Applications With Practical Perspectives, Chris Mi, M. Abul Masrur, Wiley, 2011

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POWER ELECTRONICS & DRIVES FOR ELECTRIC VEHICLES			
Course Code	**21EEE163**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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

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 Systems, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics

15 Hours

UNIT - II

Electric Drives and Control in HEVs

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

15 Hours

UNIT – III

Vehicular Power Control Strategy and Energy Management

A Generic Framework, Definition, and Needs, Methodology to Implement, Benefits of Energy Management, Modeling and Simulation of HEV Power Electronics

10 Hours

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
21EEE163.1	1	3												
21EEE163.2	2	3												
21EEE163.3	2	3			2									1
21EEE163.4	2	3			2									1
21EEE163.5	2	3			2									2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Hybrid Electric Vehicles-Principles and Applications with Practical Perspectives, Chris Mi, M. Abul Masrur, Wiley, 2011
2. Hybrid Electric Vehicle System Modeling and Control, Wei Liu, Second Edition, Wiley,2017

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AUTOMOTIVE ELECTRONICS			
Course Code	**21EEE164**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**40**	**Credits**	**03**

Course Learning Objectives:

This course will enable students to:

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: Overview, Motoronic-engine management system, Electronic diesel control, Lighting technology, electronic stability program, adaptive cruise control, Infotainment System.

Automotive Sensors & Measuring Principle: 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.

15 Hours

UNIT-II

In Vehicle Networking: Need for In-vehicle Networking, Vehicle buses. Overview of CAN, LIN, Flex Ray, MOST protocols. Vehicular ad hoc networks (VANETs).

AUTOSAR Concepts: Architecture, Methodology and Application Interfaces. ECU SW Architecture, Virtual Function Bus, Abstraction Layer, BSW, RTE, ECU Communication

15 Hours

UNIT-III

Architecture of Electronic Systems & Control Units: Basics and Overview, vehicle system architecture. Control units, Operating conditions, Design and data processing. Digital modules in the control unit. Automotive Applications. **10 Hours**

TEXT BOOKS:

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.

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
21EEE164.1	2													
21EEE164.2	2	1	1						3	3	1		1	
21EEE164.3	1	1	1						3	3	1		2	3
21EEE164.4	1									1			1	2
21EEE164.5	2		1						3	3	1		1	2

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BATTERY STORAGE AND FUEL CELLS FOR ELECTRIC VEHICLES			
Course Code	**20EEE261**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**SEE Marks**	**50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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- Electrochemical Batteries, Ultracapacitors, Ultra-High-Speed Flywheels, Hybridization of Energy Storages.

10 Hours

UNIT – II

Fuel Cells - 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 -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 **16 Hours**

UNIT - III

Battery Characterization Comparison of Different Energy Storage Technologies for HEVs, Modeling Based on Equivalent Electric Circuits, 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.

14 Hours

Course Outcomes:

At the end of the course student will be able to

1. Describe various energy storage technologies used in EVs
2. Analyze operating principle and characteristics of fuel cells to be used in EVs
3. Analyze and design various hybrid electric drive train configurations
4. Compare and model various energy storage devices used in HEV
5. Analyze battery charge control and charge management of storage devices.

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
20EEE261.1	3													
20EEE261.2	2	3												1
20EEE261.3	2	3												2
20EEE261.4	2	3												2
20EEE261.5	2	3												2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **1** full question from **Unit - I** & two full questions each from **Unit – II** and **Unit – III**.

TEXTBOOKS:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press, 2010.
2. Hybrid Electric Vehicles-Principles and Applications With Practical Perspectives, Chris Mi, M. Abul Masrur, Wiley, 2011

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ELECTRIC VEHICLE BATTERY CHARGING METHODS AND TOPOLOGIES			
Course Code	**21EEE262**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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: 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: 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: 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

15 Hours

UNIT – II

ELECTRIC VEHICLE BATTERY CHARGING: 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, The 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: 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 **15 Hours**

UNIT – III

ELECTRIC VEHICLE BATTERY PERFORMANCE:

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

10 Hours

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
21EEE262.1	3													
21EEE262.2	2	3												2
21EEE262.3	2	3												1
21EEE262.4	2	3												2
21EEE262.5	2	3												2

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Electric vehicle battery systems by Sandeep Dhameja, Newnes Publishing, 2002

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MODELING AND CONTROL OF HYBRID ELECTRIC VEHICLES			
Course Code	**21EEE263**	**Course Type**	**PEC**
Teaching Hours/Week (L:T:P)	**3:0:0:J**	**CIE+SEE Marks**	**50+50**
Total Hours	**40**	**Credits**	**03**

J -The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning 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 - 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 **15 Hours**

UNIT – II

Modeling and Parameter Estimation of Energy Storage System - 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

8 Hours

Hybrid Electric Vehicle Vibration, Noise, and Control - Basics of Noise and Vibration, General Description of Noise, Vibration, and Control in Hybrid Electric Vehicles.

8 Hours

UNIT – III

Performance Analysis of Hybrid Electric Vehicle - Hybrid Electric Vehicle Simulation System, Typical Test Driving Cycles, Sizing Components and Vehicle Performance Analysis, Fuel Economy, Emissions, and Electric Mileage Calculation

9 Hours

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→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ **Course Outcomes**													1	2
21EEE263.1	2	3												1
21EEE263.2	2	3												1
21EEE263.3	2	3												1
21EEE263.4	2	3												1
21EEE263.5	2	3												1

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

1. Hybrid Electric Vehicle System Modeling and Control, Wei Liu, Second Edition, Wiley, 2017

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OPEN ELECTIVES

NON-CONVENTIONAL ENERGY SYSTEMS			
Course Code	**21EE8X10**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Prerequisite:

Students are expected to have a fundamental knowledge of Basic Electrical Engineering (20EE105)

Course Learning Objectives (CLO):

1. To illustrate the principle of extraction of energy from conventional, nonconventional sources.
2. To demonstrate 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: 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.

3 Hours

Solar Energy Basics: 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. **5 Hours**

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, Solar Green House.

4 Hours

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, Applications- Street lighting, Domestic lighting and Solar Water pumping systems. **4Hours**

UNIT – II

Energy Storage: Introduction, Necessity of Energy Storage and Methods of Energy Storage (Classification and brief description using block diagram representation) **4 Hours**

Wind Energy: 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.

4 Hours

Biomass Energy: 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 **6 Hours**

UNIT-III

Energy From Ocean: 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

5 Hours

Emerging Technologies: Fuel Cell, Small Hydro Resources, Hydrogen Energy and Wave Energy (Principle of Energy generation using block diagrams, advantages and limitations)

4 Hours

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
20EE8X10.1	2	3				1	2	1				
20EE8X10.2	2	3				1	2	1				
20EE8X10.3	2	3				1	2	1				
20EE8X10.4	2	3				1	2	1				1
20EE8X10.5	2	3				1	2	1				

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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

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Electric Vehicles Technology			
Course Code	**21EE8X79**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**40**	**Credits**	**03**

Prerequisites: Applicable for all Engineering Stream except E&E

Course Learning 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: 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: 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 trains. **14 Hours**

UNIT - II

Energy storage for EV and HEV: 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:

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. **16 Hours**

UNIT - III

Design of Electric and Hybrid Electric Vehicles: 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.

10 Hours

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 & PSO														
Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO	
↓ Course Outcomes													1	2
21EE8x79.1	2	3												
21EE8x79.2	1	2	3											
21EE8x79.3	1	2	3											2
21EE8x79.4	1	2	3											1
21EE8x79.5	1	2	2										3	1

1: Low 2: Medium 3: High

SEE QUESTION PAPER PATTERN:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

TEXTBOOKS:

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2003
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, M. Ehsani, Y. Gao, S.Gay and Ali Emadi, CRC Press, 2005

REFERENCE BOOKS:

1. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.
2. Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau, OXFORD University, 2001
3. Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Chris Mi, M. Abul Masrur, David Wenzhong Gao, Wiley Publication, 2001

E-Books / MOOC:

1. Introduction to Mechanics | Coursera
2. NPTEL :: Electrical Engineering - Introduction to Hybrid and Electric Vehicles
3. Electric Vehicles - Part 1 - Course (nptel.ac.in)
4. Hybrid Vehicles (edX) | MOOC List (mooc-list.com)
5. NPTEL: Electrical Engineering - Introduction to Hybrid and Electric Vehicles
6. Electric Cars: Technology | My MOOC (my-mooc.com)

OPEN ELECTIVE - (VII Semester) – 2024

Sl. No	Code	Name	Intake
1.	**21HU8X03**	**Intellectual property rights** *(for all except Robotics & except for those who have taken the subject in the VI semester)*	65
2.	**21CV8X07**	**Environment Impact Assessment** *(for all except Civil & except for those who have taken the subject in the VI semester)*	60
3.	**21ME8X08**	**Industrial Pollution Control** *(for all except Mechanical & except for those who have taken the subject in the VI semester)*	60
4.	**21EE8X10**	**Non-Conventional Energy Systems** *(for all except EE, Mech.)*	60
5.	**21CS8X15**	**Essentials of Information Technology** (for all except CS, CCE, AIML & IS)	60
6.	**21EC8X18**	**Consumer Electronics** (for all except EC)	60
7.	**21ME8X28**	**Operations Management and Entrepreneurship** *(for all exceot Robotics, Mechanical & except for those who have taken the subject in the VI semester)*	60
8.	**21ME8X33**	**Human Resource Management** (for all except Mechanical)	60
9.	**21HU8X37**	**Linguistics and Language Technology** (for all)	60
10.	**21BT8X40**	**Bio Fuel Engineering** (for all except BT & *except for those who have taken the subject in the VI semester)*	60
11.	**21ME8X65**	**Automotive Engineering** (For all except Mechanical)	60
12.	**21CV8X67**	**Disaster Management** (For all except Civil)	60
13.	**21HU8X68**	**Introduction to Yoga** *(for all except for those who have taken the subject in the VI semester)* ***(The classes will be conducted from 6.30 a.m. to 7.30 a.m.)***	50
14.	**21HU8X70**	**Overview of Indian Culture and Arts** (for all *except for those who have taken the subject in the VI semester)*	50
15.	**21HU8X71**	**Principles of Physical Education** (The classes will be conducted from 5.30 p.m. to 6.30 p.m.. Those who are willing to come at 5.30 p.m. should only register) & for all *except for those who have taken the subject in the VI semester*	50
16.	**21HU8X72**	**Introduction to Japanese language** (for all) (Students with no backlogs, CGPA should be above 7.0 & who have intention to work for Japanese companies in India or Japan) – **Registration fee for this subject is Rs.1500/- & classes will be held on Saturday)**	60
17.	**21ME8X75**	**Sustainable Development Goals** (for all *except for those who have taken the subject in the VI semester)*	60
18.	**21CS8X80**	**Internet of Things** (for all except EC, CS, CCE, AIML, IS & Robotics)	30
19.	**21IS8X83**	**Software Engineering Practices** (for all except CS, AIML, CCE & IS)	60
20.	**21IS8X84**	**Introduction to Cyber Security** (for all except CS, CCE & IS)	60
21.	**21EC8X85**	**Space Technology & Applications** (for all except E&C)	60
22.	**21ME8X88**	**Marketing Management** (for all except Mechanical & *those who have taken the subject in the VI semester)*	60
23.	**21CC8X94**	**Next Generation Wireless Networks** (for all except CCE & *except for those who have taken the subject in the VI semester)*	60
24.	**21AI8X95**	**Introduction to Artificial Intelligence & Machine Learning** (for all except AIML, CCE, CS, IS & Robotics & *except for those who have taken the subject in the VI semester)*	60
25.	**21RI8X91**	**Micro Aerial Vehicle** (for all except Robotics)	40
26.	**21CV8X96**	**Sustainability Engineering** (for all)	60

INTELLECTUAL PROPERTY RIGHTS

Course Code	**21HU8X03**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Learning 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 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.	8
Agreements and Treaties 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	8

UNIT - II

Basics of Patents and Concept of Prior Art 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.)	8

Patent filing procedures 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	8

UNIT - III

Case Studies: 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)	7

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 & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
CO1		3	3	2		3			2	2		3		
CO2	2	2	3			3		3	1	1	2	2		
CO3	2			2		3			2	2	2	3		
CO4			1	1		3			1	2		3		
CO5	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.	WTO and International Trade by M B Rao. 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.	"Practical Approach to Intellectual Property Rights"; Rachna Singh Puri and Arvind Vishwanathan, 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/

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ENVIRONMENTAL IMPACT ASSESSMENT			
Course Code	**21CV8X07**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

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: 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.

16 Hours

UNIT - II

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.

10 Hours

UNIT – III

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.

13 Hours

Course Outcomes:

At the end of the course the 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 Articulation Matrix :

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1				2	3	2					2	3	
CO2	1	1				2	3	2					2	3	
CO3	1	1				2	3	2					2	3	
CO4	1	1				2	3	2		3			2	3	
CO5	1	1		3		2	3	2				3	2	3	

Note:- 1:Low 2:Medium 3: High

TEXTBOOKS:

1. Noble, L. 2010. Introduction to environmental impact assessment. A Guide to Principles and Practice. 2nd edition. Oxford University Press, Don Mills, Ontario.
2. Larry W. Canter, Environmental Impact Assessment, McGraw Hill Inc. Singapore, 1996

ADDITIONAL REFERENCE MATERIALS

1. Morris and Therivel, 2009. Methods of Environmental Impact Assessment, 3rd edition. New York, NY: Routledge.
2. Hanna, K.S. 2009. Environmental impact assessment. Practice and Participation. 2nd edition. Oxford, University Press, Don Mills, Ontario.

NPTEL SOURCES

http://nptel.ac.in/courses/120108004/
http://nptel.ac.in/courses/120108004/module3/lecture3.pdf

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INDUSTRIAL POLLUTION CONTROL			
Course Code	**21ME8X08**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives: This Course will enable students to,	
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

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

Meteorology, Wind rose, Lapse rate, plume dispersion studies & Numerical problems

15 Hours

UNIT – II
Separation techniques 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** 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.. **15 Hours**
UNIT – III
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. **9 Hours**

Course Outcomes:

At the end of the course the student will be able to

CO 1	Identify the various types of pollutants and distinguish between them with regards to Particulate matters and AQI.
CO 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.
CO 3	Explain the Particulates and fly ash separation techniques, compare and Interpret their efficiency.
CO 4	Illustrate Formation, measurement and control techniques for Smoke and gaseous pollutants
CO 5	Identify Effects of water, soil, plastics and odor pollution on environmental Pollution and explain the Legal aspects of pollution control.

TEXTBOOKS:

1. "Environmental Pollution Control Engineering, *Wiley Eastern Ltd.*,
2. "Introduction to Environmental Engineering & Science", Gilbert M Masters, PHI,1995
3. "Environmental Pollution Control Engineering, *C. S RAO New Age Int.*

REFERENCE BOOKS:

1. *"Air Pollution"*, Henry C. Perkins, Mc-Graw Hill, 1974.
2. *"Air Pollution control"*, W. L. Faith, *John Wiley*

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/105106119/36

Course Articulation Matrix

Course Code / Name : 21ME8X08/ Industrial Pollution Control														
Course Outcomes (CO)	**Program Outcomes (PO)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-21ME8X08.1	2								1	1		1		
C-21ME8X08.2	2								1	1		1		
C-21ME8X08.3	2								1	1		1		
C-21ME8X08.4	2								1	1		1		
C-21ME8X08.5	2								1	1		1		

1: Low 2: Medium 3: High

Scheme of SEE Question Paper

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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NON-CONVENTIONAL ENERGY SYSTEMS			
Course Code	**21EE8X10**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Eligible Students: For all engineering stream except E&E and Mechanical Engineering

Prerequisite:
Students are expected to have a fundamental knowledge of Basic Electrical Engineering (18EE104)

Course Learning Objectives (CLO):

1. To illustrate the principle of extraction of energy from conventional, nonconventional sources.
2. To demonstrate 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: 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.

3 Hours

Solar Energy Basics: 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.

5 Hours

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, Solar Green House.

4 Hours

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, Applications- Street lighting, Domestic lighting and Solar Water pumping systems.

4 Hours

UNIT – II

Energy Storage: Introduction, Necessity of Energy Storage and Methods of Energy Storage (Classification and brief description using block diagram representation)

4 Hours

Wind Energy: 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.

4 Hours

Biomass Energy: 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

6 Hours

UNIT – III

Energy From Ocean: 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

5 Hours

Emerging Technologies: Fuel Cell, Small Hydro Resources, Hydrogen Energy and Wave Energy (Principle of Energy generation using block diagrams, advantages and limitations)

4 Hours

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
21EE8X10.1	2	3				1	2	1				
21EE8X10.2	2	3				1	2	1				
21EE8X10.3	2	3				1	2	1				
21EE8X10.4	2	3				1	2	1				
21EE8X10.5	2	3				1	2	1				

1: Low 2: Medium 3: High

SEE Question Paper Pattern:

- There will be **8** questions of **20** marks each in the question paper categorized into **3 Units** as per the syllabi & contact hours. The student will have to answer **5** full questions, selecting **2** full questions each from **Unit - I**&**Unit – II** and **1** full question from **Unit – III**.

TEXTBOOK:

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

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ESSENTIALS OF INFORMATION TECHNOLOGY			
Course Code	**21CS8X15**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

1. Outline the fundamentals of python programming.
2. Implement the object oriented concepts using python programming.
3. Describe the basic concepts of Relational Database Management System.
4. Apply the normalization to the Databases and develop databases using SQL and PL/SQL Queries.
5. Develop the data base connectivity in integration with python and perform various Database operations.

UNIT - I

PROGRAMMING FUNDAMENTALS Introduction to Programming: Why Programming, What is Computer Program, What is an Algorithm, Flowchart, Pseudo Code; Python Fundamentals: – Introduction to python, Variables and Data Types, Comments, Input Function, Operators, Coding Standards, Integrated Development Environment(IDE) ;Control Structures: Selection Control Structures, ,Looping/Iterative Control Structures; Data Structures: String , List, Dictionary and Tuple ,Set, Functions: Built-in functions, User-defined Functions, Recursion.

OBJECT ORIENTED PROGRAMMING USING PYTHON Introduction to Object Oriented Paradigm: Abstraction and Entity, Encapsulation and Data hiding, Class and Object, Unified Modelling Language (UML), Object Oriented Approach, Class Variables, Class methods and Static Methods, Documentation, Inheritance & Polymorphism: UML: is-a relationship
(Generalization), Types of Inheritance, Multiple Inheritance, Polymorphism, Benefits of OOP,
Memory Management in Python, Relationships: has-a relationship: Aggregation & Composition, uses-a relationship; File handling, Exception Handling, Raising Exceptions

15 Hours

UNIT - II

RELATIONAL DATABASE MANAGEMENT SYSTEM Data and Need for DBMS: Data – Is it important, What is Data, Do we need to store data, How to Store / Handle Data, What is DBMS and its Models, Functional Needs of DBMS, Data perspectives in DBMS; Relational Model and Keys: What is RDBMS, Data representation in RDBMS, Keys in RDBMS; Database Development Life Cycle; Data Requirements; Logical Database Design: Different Approaches in Logical Design, ER Modeling, ER Notations, Steps in ER Modeling; Physical Database Design: Converting ER Model to Relational Schema ;Normalization: Functional Dependency, First
Normal Form: 1NF, Second Normal Form: 2NF, Third Normal Form: 3NF, Normalization
Guidelines;

Implementation with SQL: What is SQL, Data types and Operators in SQL, SQL Statements: SQL - Built-in Functions; SQL - Group by and Having Clauses Joins: Inner Join, Outer Join, Self-Join, Sub Queries: Independent Sub queries, Correlated Sub queries, Index, Views,
Transactions, PL/SQL

15 Hours

UNIT - III

PYTHON DATABASE INTEGRATION Why Database Programming, Python Database
Integration – Pre-requisites and Installation, SELECT Operation: Retrieve Data from Database, Attributes of Cursor object, Bind variables, CREATE and INSERT Operation: Creating a table, Insert Operation, Inserting Multiple Records, UPDATE Operation, DELETE Operation, Exception Handling.

9 Hours

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

1. Explain the basic program constructs of Python Programming.
2. Design and apply the object oriented programming construct using Python to build the real world application.
3. Summarize the concepts related to Relational Database Management System.
4. Design and develop databases from the real world by applying the concepts of Normalization using SQL and PL/SQL.
5. Perform the various Database operations by connecting Python with Database.

Table-2: Mapping Levels of COs to POs / PSOs

COs	Program Outcomes (POs)												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2	3		1				1	1		1		3	
CO2	1	2	3		1				1	1		1		3	3
CO3	1	2	3											3	
CO4	2	3												3	3
CO5	1	2	3		1				1	1		1		3	2

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXTBOOKS:

1. Kenneth A. Lambert, "The Fundamentals of Python: First Programs, 2012", Cengage Learning.
2. Magnus Lie Hetland, "Beginning Python from Novice to Professional", Second Edition.
3. Mark Summerfield, Programming in Python 3 – "A Complete Introduction to the Python Language", Second Edition.
4. Elmasri, Navathe, "Fundamentals of Database Systems", Third edition, Addison Wesley

REFERENCE BOOKS:

1. Y. Daniel Liang, "Introduction to Programming Using Python", Pearson, ISBN:9780-13274718-9, 2013.
2. Raghu Ramakrishnan and Johannes Gehrke: "Database Management Systems" (Third Edition), McGraw-Hill, 2003.

SEE SCHEME:

There will be **8** questions of **20** marks each in the question paper divided into**3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I & Unit – II** and **1** full question from **Unit-III**

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CONSUMER ELECTRONICS			
Course Code	**21EC8X18**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This course will enable the students to

1. Learn and design operating principles of "real world" electronic devices
2. Study broader view of key principles of electronic device's operation and presents a block circuit diagram.
3. Learn to integrate the many different aspects of emerging technologies and able to build unique mix of skills required for careers.

UNIT – I

Sound: Properties of sound and its propagation, Transducers (Micro Phone, Loud Speakers), enclosures, mono-stereo, Amplifiers, Multiplexers, mixers, Synthesizers.
Vision: B/W TV, CTV concepts, B/W & Color Cameras, Displays.

15 Hours

UNIT – II

Recording and Playback: Optical discs; recording and playback, audio and video systems, Theatre Sound, Studios, Editing.
Communications and Broadcasting: Switching Systems, Land lines, Modulation, Carrier, Fiber optics, Radio and TV broad casting
Data Services: Data services, mobiles, terrestrial & Satellite Systems, GPS, Computers, internet Services.

15 Hours

UNIT – III

Utilities: Fax, Xerox, Calculators, Microwave ovens, Washing Machines, A/C & refrigeration, Dishwashers, ATMS, Set -Top boxes, Auto Electronics, Industrial Electronics, Robotics, Electronics in health / Medicine, nano- technologies.

9 Hours

Course Outcomes:

At the end of the course the student will be able to

1. Recall basics of sound.
2. Recall basics of television and 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

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

Scheme of SEE Question Paper

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I & Unit – II** and **1** full question from **Unit – III**.

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OPERATIONS MANAGEMENT & ENTREPRENEURSHIP

Course code	**21ME8X28**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**(3:0:0)**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives: This Course will enable students to,

1	Define production/operations management, Classify Production and service system and different type of production systems, Understand the importance of CRM and ERP
2	Appreciate the importance of Quality tools and methods in operations management
3	Analyze the data draw variable process control charts and determine process capability; Understand salient issues concerning reliability
4	Understand the issues related to entrepreneurship, characteristics of an entrepreneur and different studies carried out during project appraisal.
5	Identify and differentiate the different national and state level funding agencies.

UNIT – I

Introduction to Production/ Operations Management: Concept of production, Classification of production systems, Production Management, Concept of operations, Distinction between Manufacturing Operations and Service Operations, Objectives of Operations Management (Customer Service and Resource utilization/ Competitive advantage through Quality-Delivery-Cost), Scope of Operations Management. Introduction to Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP).

7 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,

Philosophy of statistical process control and modeling process quality: 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)

9 Hours

UNIT – II

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.

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.

8 Hours

Entrepreneurship: Concept of Entrepreneurship, Stages in entrepreneurial process, Role of entrepreneurs in Economic Development, Barriers to Entrepreneurship, Meaning of Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneurs, Intrapreneur - an emerging Class.

Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

Application of Operations Management concepts in Facility/ Business Location: General procedure for making locations decisions, Numerical Problems on application of Breakeven analysis and Transportation method to make location decisions.

8 Hours

UNIT – III

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, Impact of Liberalization, Privatization, Globalization on SSI. Effect of WTO/GATT on SSI, Supporting Agencies of Government for SSI, Ancillary Industry and Tiny Industry (Definition Only)

Institutional Support: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

7 Hours

Course Outcomes (CO)

CO 1	Differentiate production and service systems. Discuss continuous and intermittent production systems with their advantages and disadvantages. Discuss CRM and ERP systems.
CO 2	Discuss Total Quality Management tools and methods. Solve problems on fundamentals of statistics and normal distribution.
CO 3	Draw and Analyze variable process control charts and determine process capability. Calculate reliability of series and parallel systems using the information on failure rate and time.
CO 4	Discuss entrepreneurship, characteristics of an entrepreneur and barriers to entrepreneurship. Discuss the elements of a project report and feasibility studies conducted in the project appraisal.
CO 5	Identify and differentiate the national and state level funding agencies. Discuss the effect of GATT and WTO on Indian economy.

TEXTBOOKS:

1. **Production / Operations Management**, Joseph G Monks, McGraw Hill Books
2. **Production and Operations Management**, William J Stevenson, Tata McGraw Hill, 8th Edition.
3. **Statistical Quality Control**: RC Gupta, Khanna Publishers, New Delhi, 2005.
4. **Total Quality Management**: Dale H. Besterfield, Pearson Education, 2003.
5. **Dynamics of Entrepreneurial Development & Management** – Vasant Desai – Himalaya Publishing House
6. **Entrepreneurship Development** – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).

REFERENCE BOOKS:

1. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher.
2. **Statistical Process Control and Quality Improvement:** Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
3. **Statistical Quality Control for Manufacturing Managers:** W S Messina, Wiley & Sons, Inc. New York, 1987
4. **Statistical Quality Control:** Montgomery, Douglas, 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ (ISBN 0-471-65631-3).
5. **Principles of Quality Control:** Jerry Banks, Wiley & Sons, Inc. New York.
6. **Entrepreneurship Development** – S.S.Khanka – S.Chand & Co.

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/110105067/
2. https://www.edx.org/course/operations-management-iimbx-om101-1x

Course Articulation Matrix

Course Code / Name:21ME8X28/ Operations Management & Entrepreneurship															
Course Outcomes (CO)	**Program Outcomes (PO)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C-21ME8X28.1	3	1	0					1	1	1	1				
C-21ME8X28.2	1	2	0						1	1	3				
C-21ME8X28.3	2	2	0				1	0	1	1	3				
C-21ME8X28.4	3	1	0			1	0	1	1		2				
C-21ME8X28.5	1	1	0			1	1	1	1		3				

1: Low 2: Medium 3: High

Scheme of SEE Question Paper

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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HUMAN RESOURCE MANAGEMENT			
Course Code	**21ME8X33**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

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:
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.
8 Hours

Recruitment: 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
8 Hours

UNIT – II

Training and development: Training v/s development, stages in training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.
Compensation: employee remuneration, rewards, Wage and Salary Administration, Bonus, fringe benefits. Internal Mobility, External Mobility, Trade union Act (Amendment) 2001.
7 Hours

Employee Grievances: Employee Grievance procedure. Discipline procedure
Collective bargaining; Characteristics, Necessity, Forms
Safety & Health; Industrial accidents, Safety
Quality circle; Meaning, Structure
8 Hours

UNIT – III
IHRM. Managing IHRM. e-HR Activities, Global recruitment, selection, expatriates. Industrial conflict – Causes, Types, Prevention and Settlement. **e-HRM**; Aspects of e-HRM,e-Job design & Analysis, Ethical issues in employment **8 Hours**
Course Outcomes (CO):
At the end of the course the student will be able to:
CO 1 Describe the basic concepts of HRM & HRP.
CO 2 Elucidate the HRM functions of recruitment, selections, appraisal etc.
CO 3 Apply the training, development and compensation methods in HRD.
CO 4 Identify the employee grievances and to spell out the remedial measures.
CO 5 Infer the concepts of e-HRM and I-HRM.
TEXTBOOK:
1. Essentials of Human Resource Management & Industrial Relations-P Courseba Rao, Third Revised Edition
REFERENCE BOOKS:
1) Human Resource Management - John M. Ivancevich, 10/e, McGraw Hill.
2) Human Resource Management-Flippo
3) Human Resource Management - Lawrence S. Kleeman, Biztantra , 2012.
4) Human Resource Management – Aswathappa K HPH
MOOC/NPTEL Resources:
1) http://edx.nimt.ac.in/courses/course-v1:nimtX+PGDM1212+2017_H1/about
2) http://nptel.ac.in/courses/122105020/

Course Articulation Matrix

Course Code / Name : 21ME8X33 / HUMAN RESOURCE MANAGEMENT														
Course Outcomes (CO)	**Program Outcomes (PO)**												**PSO**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C- 21ME8X33.1	3	-	-	-	-	1	-	-	1	1	-	1	-	-
C-21ME8X33.2	3	-	-	-	-	1	-	-	1	1	-	1	-	-
C-21ME8X33.3	3	-	-	-	-	1	-	-	1	1	-	1	-	-
C-21ME8X33.4	3	-	-	-	-	1	-	-	1	1	-	1	-	-
C-21ME8X33.5	3	-	-	-	-	1	-	-	1	1	-	1	-	-

1: Low 2: Medium 3: High

Scheme of SEE Question Paper

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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LINGUISTICS & LANGUAGE TECHNOLOGY

Course Code	**21HU8X37**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Learning 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 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).	8
Phonology and Morphology Perspectives in Linguistics, Phonemes, Allophones, Phonemic Analysis, Morphology and Morphemes, Word building process, Morphological Analysis.	8

UNIT - II

Syntax Constituent structure (Simple Sentence, Noun Phrase, Verb Phrase, Prepositional Phrase, Adjective Phrase, Adverb Phrase, Structure Rules), Tree Diagrams, Case	16

UNIT – III

Sociolinguistics & Psycholinguistics, Artificial Intelligence Notion of Language Variety, Languages in Contact, Language and Mind, Error Analysis.	7

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 & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
CO1		1			1	1			1			2		
CO2			2						2	2				
CO3	2	3		3					3	2				
CO4					2				1	2				
CO5		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.

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BIOFUEL ENGINEERING			
Course Code	**21BT8X40**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

***Prerequisites*:** Nil
***Co-requisites*:** Nil

Course Learning Objectives:

The objective of this course is

- To learn the fundamental concepts of biofuels, types of biofuels, their production technologies.
- To learn the concepts of feedstock utilization and energy conversion technologies.

UNIT – I

LIQUID BIOFUELS

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

15 Hours

UNIT – II

BIOHYDROGEN AND MICROBIAL FUEL CELLS

Enzymes involved in H_2 Production; Photobiological H_2 Production: Biophotolysis and Photofermentation; 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.

15 Hours

UNIT – III

RECOVERY OF BIOLOGICAL CONVERSION PRODUCTS

Biogasification 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.

9 Hours

Course Outcomes:

At the end of this course, student should 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.

Mapping of POs &COs:

	PO											
CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1		M							L			
CO2		M							L			
CO3		M							L			
CO4		M							L			
CO5		M							L			

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.

SEE QUESTION PAPER PATTERN:

Unit No.	I	II	III
Questions to ask (20 marks/Qn)	3	3	2
Questions to answer	2	2	1

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AUTOMOTIVE ENGINEERING			
Course Code	**21ME8X65**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives: **This Course will enable students to,**	
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:
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 components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements, crankshaft/flywheel position sensor, accelerator pedal sensors, engine coolant water temperature sensor.

8 Hours

FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Fuel mixture requirements for SI engines, types of carburetors, simple 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.

5 Hours

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)

2 Hours

UNIT – II

POWER TRAINS:

Clutches- Single plate, multiplate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission, Constant mesh gear box, Synchromesh gear box, principle of automatic transmission, Vehicle Speed Sensors, calculation of gear ratios, Types of transmission systems. No numerical.

8 Hours

DRIVE TO WHEELS:

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.

5 Hours

SUSPENSION AND SPRINGS:

Requirements, leaf spring, coil spring, Torsion bar suspension systems, independent suspension for front Wheel, Air suspension system**.**

2 Hours

UNIT – III

BRAKES:

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.

5 Hours

TYRES

Desirable tyre properties, Types of tyres.

1 Hour

AUTOMOTIVE EMISSION:

Automotive exhaust emissions, sources and emission control method: EGR, SCR, Emission Standards, Exhaust sensors.

Electric Vehicles.

3 Hours

Course Outcomes (CO):

At the end of the course the student will be able to

CO 1	**Describe** and demonstrate the layout of an automobile and components of an automobile engine. Explain cooling and lubrication systems.
CO 2	**Explain** and demonstrate the fuel supply and Ignition systems for SI and CI engines.
CO 3	**Describe** and demonstrate the transmission system
CO 4	**Explain** and demonstrate the components of drive to wheel and suspension system, calculate the parameters of steering geometry.
CO 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.

TEXTBOOKS:

1. Automotive Mechanics by S. Srinivasan, Tata McGraw Hill, 2003
2. Automobile Engineering, Kirpal Singh, Vol I and II, 2013.
3. Automotive Electrical and Electronics, A. K. Babu, Khanna Publishers, 2nd edition, 2016

REFERENCE BOOKS :

1. Automobile Engineering, R. B. Gupta, Satya Prakashan, 4th Edn., 1984 .
2. Automobile Engineering, Narang, Khanna Publishers 2002
3. Automotive Mechanics, Crouse, McGraw Hill 2002
4. Automotive Mechanics, Joseph Heithner 2000
5. Automobile Mechanics by N. K. Giri, Khanna publishers 2002
6. Newton and Steeds Motor Vehicle, Butterworth, 2nd Edn. 1989.
7. Automobile Engineering by K. K. Jain and R. B_ Arshana, Tata McGraw Hill, 2002
8. Automobile Mechanics, A.K. Babu & S.C. Sharma, T.R. Banga, Khanna Book Publishing
9. A Textbook of Automobile Engineering, R.K. Rajput, Laxmi Publications

List of proposed Experiments in Automotive Laboratory: 4 Hours

1. Study of Automotive - Chassis & superstructure/body and its functions. Also involves study of cut section of wheel & tyres (bias and radial types).
2. Study of more commonly used tools and equipment in automotive shop.
3. Study of carburetors and petrol & diesel fuel injection systems
4. Demonstration and study of Front axle and steering system
5. Demonstration and study of various suspension systems
6. Power train - Dismantling and assembly of single/multi cylinder Engine.
7. Power train - Study of clutch mechanism. Demonstration and study of dry friction clutches - Single plate & multi-plate types
8. Power train - Demonstration and study of transmission system - Gear box
9. Power train - Demonstration and study of Universal joints, propeller shaft, final drives, differential, and rear axles
10. Demonstration and study of brake mechanism (hydraulic type) and study of disc and drum brakes
11. Field visit to Automotive Servicing Station - Study of electrical system, wheel alignment (measuring and adjustment of castor, camber, king-pin inclination, toe-in and toe-out), automotive emission control systems.

(The details of each experiment to be given out as handout to each student or may be uploaded in Intranet)

Course Articulation Matrix:

Course Code / Name: 21ME8X65 / Automotive Engineering														
Course Outcomes (CO)	**Program Outcomes (PO)**												**PSO**	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-21ME8X65.1	3	1	-	-	-	1	-	-	3	1	-	1	3	3
C-21ME8X65.2	3	1	-	-	-	1	-	-	3	1	-	1	1	3
C-21ME8X65.3	3	1	1	-	-	1	-	-	3	1	-	1	3	3
C-21ME8X65.4	2	3	1	-	-	1	-	-	3	1	-	1	2	3
C-21ME8X65.5	3	1	1	-	-	1	1	1	3	1	-	1	2	3

1: Low 2: Medium 3: High

Scheme of SEE Question Paper

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

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DISASTER MANAGEMENT			
Course Code	**21CV8X67**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

1. Understand difference between Disaster, Hazard, Vulnerability, and Risk.
2. Know the Types, Trends, Causes, Consequences and Control of Disasters
2. Apprehend Disaster Management Cycle and Framework.
3. Know the Disaster Management in India
4. Appreciate Applications of Science and Technology for Disaster Management.

UNIT – I

Understanding Disasters: 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: 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

15 Hours

UNIT – II

Disaster Management Cycle and Framework: Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, 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,YokohamaStretegy, Hyogo Framework of Action

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

15 Hours

UNIT – III

Applications of Science and Technology for Disaster Management: 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: 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:

After completion of this course the students 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.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3	2				1	2			
CO2						3	2				1	2			
CO3						3	2				1	2			
CO4						3	2				1	2			
CO5						3	2				1	2			

Note:1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

REFERENCE BOOKS:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. https://nidm.gov.in/PDF/pubs/DM%20in%20India.pdf, Disaster Management in India, MHA, 2011.
3. World Disasters Report, 2018. International Federation of Red Cross and Red Crescent, Switzerland
4. Encyclopedia of disaster management, Vol I, II and III Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
5. Encyclopedia of Disasters – Environmental Catastrophes and Human Tragedies, Vol. 1 & 2, Angus M. Gunn, Greenwood Press, 2008
6. Disasters in India Studies of grim reality, AnuKapur& others, 2005, 283 pages, Rawat Publishers, Jaipur.
7. Management of Natural Disasters in developing countries, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages
8. Natural Disasters, David Alexander, Kluwer Academic London, 1999, 632 pages
9. Disaster Management Act 2005, Publisher by Govt. of India
10. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management, https://ndma.gov.in/en/publications.html#
11. NIDM Publications https://nidm.gov.in/books.asp
12. High Power Committee Report, 2001, J.C. Pant
13. Disaster Mitigation in Asia & Pacific, Asian Development Bank
14. National Disaster Management Policy, 2009, GoI
15. Disaster Preparedness Kit, 2017, American Red Cross,http://pchs.psd202.org/documents/mopsal/1539703875.pdf.
16. Subramanian R., "Disaster Management", 2018 Vikas Publishing House Pvt Ltd.

Note: There will be 8 questions of 20 marks each in the question paper divided into 3 Units as per the syllabi & contact hours and the student will have to answer 5 full questions, selecting 2 full questions from Unit - I & Unit – II and 1 full question from Unit – III.

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INTRODUCTION TO YOGA

Course Code:	**21HU8X68**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Learning 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: 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.	**09 Hours**
Classification of Yoga and Yogic texts:Yogasutra of Patanjali, Hatha yogic practices- Asanas, Pranayama, Dharana, Mudras and bandhas.	**07 Hours**

UNIT – II

Yoga and Health: Concept of health and Diseases-Yogic concept of body – pancakosaviveka, Concept of disease according to Yoga Vasistha.	**06 Hours**
Yogic concept of healthy living- rules & regulations, yogic diet, ahara, vihara. Yogic concept of holistic health.	**04 Hours**
Applied Yoga for elementary education:Personality development- physical level,mental level,emotional level. Specific guidelines and Yoga practices f**or** - Concentration development,Memory development	**04 Hours**

UNIT - III

Yoga and physical development: 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)	**04 Hours**

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 & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
CO1						1			1			1		
CO2						1			1			3		
CO3						2			1			3		
CO4						3			2			3		
CO5						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.	MakarandMadhukar Gore, "Anatomy and Physiology of Yogic Practices: Understanding of the Yogic Concepts and Physiological Mechanism of the Yogic Practices", MotilalBanarsidass Publishers; 6 edition (2016).
3.	Swami SatyanandaSaraswati, "Asana, Pranayama, Mudra and Bandha: 1", Yoga Publications Trust.
REFERENCE BOOKS:	
1.	Science of Yoga: Understand the Anatomy and Physiology to Perfect Your Practice by Ann Swanson
2.	Yoga for Everyone : 50 Poses For Every Type of Body by Dianne Bondy
E Books / MOOCs/ NPTEL	
1.	https://onlinecourses.swayam2.ac.in/aic19_ed29/preview
2.	https://youtu.be/FMf3bPS5wDs

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OVERVIEW OF INDIAN CULTURE AND ART

Course Code	**21HU8X70**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Learning 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 What is Culture, Different aspects of Culture, Cultural expression, Importance of Culture	7
Influence of Culture Relationship of Culture with: Language, Religion and History, Gender	7

UNIT - II

Media and Culture Role of News Papers, Indian Cinema, Music, Advertisements	7
Languages, Literature and Culture 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	7

UNIT - III

Arts and Culture Indian Theatre and Performing Arts, Ritual performances, and Tuluva cultural and ritual performances.	7
(Self-study Component) **Contribution of Indian History to Culture** 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.	4

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 & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
CO1		1				3		3	3	1		3		
CO2				2		3		2	3	3		3		
CO3						3		1				1		
CO4						3		2	1	2		3		
CO5						3		3	3	3		2		

1: Low 2: Medium 3: High

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PRINCIPLES TO PHYSICAL EDUCATION			
Course Code	**20HU8X71**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

1. Appreciate and understand the value of physical education and its relationship to a healthy active lifestyle.
2. Work to their optimal level of physical fitness.
3. Show knowledge and understanding in a variety of physical activities and evaluate their own and others' performances.

UNIT - I

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)

10 Hours

UNIT – II

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 FirstAid, Scope of FirstAid, 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.

12 Hours

UNIT – III

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.

16 Hours

Course Outcomes:

At the end of the course, the student will be able to

1. Demonstrate an understanding of the principles and concepts related to a variety of physical activities.
2. Apply health and fitness principles effectively through a variety of physical activities.
3. Support and encourage others (towards a positive working environment).
4. Show self-motivation, organization and responsible behavior.

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
CO1						3			2	1		1		
CO2						3			2	1		1		
CO3						3			2	1		1		
CO4						3			2	1		1		
CO5						3			2	1		1		

1: Low 2: Medium 3: High

TEXT AND REFERENCE BOOKS:

i. A. K. Uppal, "Physical Education and Health"
ii. M. L. Kamlesh, "Fundamental Elements of physical Education",
iii. Swami Ramdev, "Yog its philosophy and practice", Divya Prakashan
iv. V. K. Sharma, "Health and Physical Education"

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INTRODUCTION TO JAPANESE LANGUAGE

Course Code	**21HU8X72**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39+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) **Grammar –** Introduction, Alphabets, Accents, Noun, Pronoun, Present Tense, Past tense **Vocabulary –** Numbers, Days, week days, months, Seasons, Nature, Dialogs and Video Clips	13
UNIT - II	
(Lessons 7-13) Communication skills – Time, Addective, Seasons, Conversation, Q&A Hobby, 5-W/1-H, Entering School/Company, Body Parts, Colours, Features etc**.**	13
UNIT - III	
(Lessons 14-20) Japanese Counting System, Birth/Death, Dialogs (Going to Party, Restaurant), My day, Success/Failure, Kanji Characters, and sentence making, Video Clips	13

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 & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
CO1						3			2	1		1		
CO2						3			2	1		1		
CO3						3			2	1		1		
CO4						3			2	1		1		
CO5						3			2	1		1		

1: Low 2: Medium 3: High

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SUSTAINABLE DEVELOPMENT GOALS

Course code	**21ME8X75**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

Sustainable Development Goals is a 2016 United Nations officially released Agendas for Sustainable approach environmental integrity, economic viability and a just society for present and future generations. It aims to provide the knowledge, skills, attitudes and values necessary to address sustainable development challenges. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace and justice. Learn more and take action. This SDG program is organized in such a way to be research-led, applied interdisciplinary program that considers sustainability in both developed and developing societies, and addresses critical global challenges put forth by UN.

UNIT – I

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: Ensuring resilience and primary needs in society

In-depth discussion and analysis of goals related to poverty, hunger, health & well-being and education

13 Hours

UNIT – II

SDGs and Society: 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

13 Hours

UNIT – III

SDGs and the Biosphere: 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.

13 Hours

Course Outcomes:

At the end of the course the student will be able to

CO 1	Summarize the UN's Sustainable Development Goals and how their aims, methodology and perspectives.
CO 2	Analyze the major issues affecting sustainable development and how sustainable development can be achieved in practice.
CO 3	Identify and apply methods for assessing the achievement/possibilities of sustainable development in Nitte gram panchayath.
CO 4	Evaluate the implications of overuse of resources, population growth and economic growth and sustainability & Explore the challenges the society faces in making transition to renewable resource use
CO 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.

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.
3. Dalby, Simon, et al. Achieving the Sustainable Development Goals: Global Governance Challenges. Routledge, 2019.
4. Sustainability: A Comprehensive Foundation by Tom Thesis and JonathanTomkin, Editors.

REFERENCE BOOKS:

1. Elliott, Jennifer. An introduction to sustainable development. Routledge, 2012.
2. Day, G.S., and P.J.H. Schoemaker (2011), Innovating in uncertain markets: 10 lessons for green technologies, MIT Sloan Management Review, 52.4: 37-45.

MOOC Resources:

1. https://www.un.org/sustainabledevelopment/poverty/

Course Articulation Matrix

Course Code / Name : 21ME/ SUSTAINABLE DEVELOPMENT GOALS														
Course Outcomes (CO)	**Program Outcomes (PO)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	**1**	**2**	**1**	**1**	**1**	**3**	**3**	**1**	**1**	**1**		**2**	**1**	**1**
2	**2**	**2**	**1**	**1**	**1**	**3**	**3**	**2**	**1**	**1**		**1**	**1**	**1**
3	**3**	**2**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**1**		**1**	**1**	**2**
4	**3**	**2**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**1**		**1**	**3**	**2**
5	**1**	**2**	**2**	**1**	**1**	**3**	**3**	**2**	**2**	**2**		**1**	**1**	**1**

1: Low 2: Medium 3: High

Scheme of SEE Question Paper

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi &contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I**&**Unit – II** and **1** full question from **Unit – III**.

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INTERNET OF THINGS – (IoT)			
Course Code	**21CS8X80**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to:

1. Learn the IoT Definitions, Design aspects
2. Identify the IoT hardware and software requirements
3. Describe IoT logical and physical design concepts
4. Implement Arduino based IoT Projects
5. Implement Raspberry Pi based IoT Projects

UNIT – I

Introduction

Introduction to IoT : Definition and characteristics, Physical design, Logical design, Enabling technologies, Levels and deployment templates, Examples: Domain specific IoTs, IoT Design and System Engineering, Discuss IoT Requirements, Hardware & Software; Study of IoT sensors, Tagging and Tracking, Embedded Products; IoT Design, (U) SIM Card Technology, IoT Connectivity and Management, IoT Security & IoT Communication.

(Text Book-1:, Chapter 1 to 4)

15 Hours

UNIT – II

Design Concepts:

IoT Logical Design:

Data types, Data structures, Control flow, Functions, Modules, Packages, File Handling, Date and time operation, Classes, Python packages of IoT, IoT Physical Design, Basic building blocks, Raspberry Pi, Linux on Raspberry Pi, Interfaces, Programming on Raspberry Pi with Python, Arduino Based IoT Project Implementation, Arduino for Project development, Internet enabled Arduino powered garage door opener, Irrigation control system, Light controller Message, controller and cloud Services

(Text Book-1: Chapter 4,5,6 ,7)

15 Hours

UNIT – III

09 Hours

Raspberry Pi based IoT Project Implementation:

Raspberry Pi for Project Development: Raspberry Pi platform, GPIO, Establishment and setting, of Raspberry Pi software, LAMP project, Home temperature, monitoring system, Webcam and Raspberry Pi camera project

(Text Book-1: Chapter 10,11,12, 13

Course Outcomes:

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

1. Acquire the fundamental knowledge of IoT Definitions, Design aspects
2. Identify the IoT hardware and software requirements
3. Design IoT logical and physical architecture
4. Implement Arduino based IoT Projects
5. Implement Raspberry Pi based IoT Projects

Table-2: Mapping Levels of COs to POs / PSOs															
COs	**Program Outcomes (POs)**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	1						1	1			1		3	
CO2	2	3						1	1			1		3	
CO3	3	1						1	1			1		3	
CO4	3	2			3			1	1			1	1	3	3
CO5	3	2			3			1	1			1	1	3	3

3: Substantial (High) **2: Moderate (Medium)** **1: Poor (Low)**

TEXTBOOKS:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-On Approach,Vijay Madisetti", 2014.
2. Donald Norris, "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", 1st Edition, McGraw Hill, 2015.

REFERENCE BOOKS:

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Pethuru Raj and Anupama C. Raman,"The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
3. Jeeva Jose," Internet of Things", Khanna Publishing House, Delhi
4. Adrian McEwen," Designing the Internet of Things", Wiley
5. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
6. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

E-Books / Online Resources:

1. Object-Oriented Analysis and Design with Applications, Grady Booch, Robert A. Maksimchuk, Michael W. Engel, Bobbi J. Young, Jim Conallen, Kelli A. Houston, Third Edition The Addison-Wesley Object Technology Series, 2007
2. Object-Oriented Modelling and Design with UML, James R Rumbaugh, Michael R. Blaha Pearson Education, 21-Nov-2011
3. Object-Oriented Analysis and Design, Ramnath, Sarnath, Dathan, Brahma, ISBN 978-1-84996-522-4,, Springer Publications, 2011.

MOOC:

1. https://www.coursera.org/specializations/internet-of-things
2. https://www.udemy.com/course/iot-internet-of-things-automation-using- raspberry-pi/
3. https://www.udemy.com/course/arduino-iot-cloud/

SEE SCHEME:

There will be **8** questions of **20** marks each in the question paper divided into**3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I & Unit – II** and **1** full question from **Unit – III.**

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SOFTWARE ENGINEERING PRACTICES			
Course Code	**21IS8X83**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students:

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: 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.

15 Hours

UNIT – II

System Models: 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.

15 Hours

UNIT – III

Project Management: 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.

9 Hours

Course Outcomes:

Students will be able to:

Sl. No.	Course Outcomes
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

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
IS2504-1.1		3	1					2					1	2
IS2504-1.2	1	3	1										1	2
IS2504-1.3	1	1	3										2	3
IS2504-1.4	1	3	2										1	2
IS2504-1.5	1	2	2										1	2

1: Low 2: Medium 3: High

TEXTBOOK:

1. Ian Sommerville, "Software Engineering", 9th Edition, Pearson Education, 2012. 82Syllabus of III & IV Semester B.E. / Computer Science &Engg.

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-RESOURCES

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

SEE Question Paper Pattern:

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2**fullquestions from **Unit-I & Unit – II** and **1**fullquestion from **Unit– III.**

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INTRODUCTION TO CYBER SECURITY			
Course Code	**21IS8X84**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students:

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

Cyberoffenses: 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]**

14 Hours

UNIT – II

Tools and methods used in Cybercrime:
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]**

12 Hours

UNIT – III

UNDERSTANDING COMPUTER FORENSICS

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]**

13 Hours

Course Outcomes:

Students will be able to:

Sl. No.	Course Outcome
IS2503.1	Comprehend the Cybercrime and its origin
IS2503.2	Analyse the cybercrimes in mobile and wireless devices
IS2503.3	Apply tools and methods used in Cyber crimes
IS2503.4	Analyse Phishing and and ID Theft
IS2503.5	Comprehend Digital Forensics

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
IS2503-1.1	2					1		3						
IS2503-1.2		3		1		2			2					
IS2503-1.3		3	2										2	3
IS2503-1.4	2					2								
IS2503-1.5								3						

(L/1 = Low 30%-49%, M/2 = Medium 50%-69%, H/3=High >70%)

TEXTBOOKS:

1. SunitBelapure 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, "Cyber security: Managing Systems, Conducting Testing, and Investigating Intrusions", Copyright © 2014 by John Wiley & Sons, Inc, ISBN: 978 -1-118 -84965 -1.
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.

SEE Question Paper Pattern:

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2**fullquestions from **Unit-I & Unit – II** and **1**fullquestion from **Unit– III.**

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SPACETECHNOLOGYANDAPPLICATIONS			
Course Code	**21EC8X85**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

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 sub system 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. Discussthethedifferentcommunicationsystemsusedforsatelliteaccess.
8. Summarise Advanced space systems for mobile communication, VSAT, GPS.

UNIT – I

Satellite communications: Introduction, Kepler's laws, definitions, orbital element, apogeeandperigeeheights, 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, Antennas.

15 Hours

UNIT – II

LaunchVehicles: Working,stages,Fuel,payloadprotection,Navigation,guidanceandcontrol,Reliability,launchingi ntoouter 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.

14 Hours

UNIT – III

Satellite Access: Introduction, Single Access, Pre-assigned FDMA, Demand-Assigned FDMA, Spade system.

Advancedspacesystems: Satellitemobileservices,VSAT,Radarsat,orbitalcommunication**.**GlobalPositioning Satellite System (GPS).

10 Hours

Course Outcomes:

At the end of the course student will be able to

1. Discuss the fundamental principles of Satellite communication systems.
2. Discuss 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. Explain the different communication systems used for satellite access and list the recent satellites that have been launched for mobile communication, GPS.

Course Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	1	-	-	-	-	-	-	-
CO2	-	3	-	-	2	1	-	-	-	-	-	-
CO3	3	-	-	1	-	1	1	-	-	-	-	-
CO4	--	-	-	-	-	1	3	-	-	-	-	-
CO5	--	-	-	-	-	3	3	2	-	-	-	-

High Assessment Details (both CIE and SEE)

TheweightageofContinuousInternalEvaluation(CIE)is50%andforSemesterEndExam(SEE)is50%.The student must obtain minimum of 20 marks out of 50 in CIE and 20 marks out of 50 in SEE and 40%intotaltoobtainapassgrade.Semester End Exam(SEE)is conducted for 100 marks (3Hoursduration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. **Methods recommended:** Two Tests (80%), Written Quiz (16%) and module assignments (4%).Course coordinator will announce the evaluation procedure at the beginning of the semester and will be recorded in the course plan.

Semester End Examination:

1. There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit- I& Unit–II and 1fullquestion from Unit– III.

TEXTBOOKS:

T1. Dennis Roddy, **"Satellite Communications"**, McGraw Hill 1996.
T2.TimothyPratt,**"SatelliteCommunications"**,WileyIndiaLtd,2006.
T3.KRamamurthy,**"RocketPropulsion"**,McMillanPublishersIndiaLtd,2010.

REFERENCE BOOKS:

R1. George Joseph, **"Fundamentals of Remote Sensing"**, Universities press, India 2003.
R2.BC Pande, **"Remote sensing and Applications"**, VIVA Books pvtltd, 2009.
R3. Meynart Roland, **"Sensors systems and next generation satellites"**, SPIE Publication.
R4.Thyagarajan ,**"Space Environment"**, ISRO Hand Book Publication.

E-Books / MOOC:

https://nptel.ac.in/courses/101106046

MARKETING MANAGEMENT			
Course Code	**21ME8X88**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	**SEE Marks**	**50**
Total Hours	**39**	**Credits**	**03**

Course Learning Objectives:

This Course will enable students to

1. Understand and learn the marketing concepts and their application to profit-orientedand non-profit oriented organizations.
2. Able to apply the marketing concepts to analyze the buying behavior & marketing segments to solve these problems.
3. Understand and learn the need for a customer orientation in product pricing & marketing research in the competitive global business environment;
4. Able to develop an understanding and acquiring skills in how to successfully design and implement marketing plans and strategies.
5. Understand and learn the concept of sales, advertising &distribution of marketing mix and its application in traditional and novel environments characterized by emerging information technologies.

UNIT - I

BASICS

Definition, Marketing Process, Dynamics, Needs, Wants & Demands, Marketing Concepts, Environment, mix, types, philosophies, Selling Vs. Marketing, organization, Industrial Vs. Consumer Marketing, Consumer goods, Industrial goods, Product hierarchy.

8 Hours

BUYING BEHAVIOUR & MARKET SEGMENTATION

Cultural, Demographic factors, Motives, types, Buying decisions, segmentation factors, Demographic, Psychographic & Geographic Segmentation, Process, Patterns.

8 Hours

UNIT - II

PRODUCT PRICING & MARKETING RESEARCH

Objectives, pricing, Decisions and Pricing methods, Pricing Management. Introduction,Uses, process of Marketing Research.

8 Hours

MARKETING PLANNING & STRATEGY FORMULATION

Components of a marketing plan, strategy formulations and the marketing process, implementation, Portfolio analysis, BCG, GEC grids.

8 Hours

UNIT - III

ADVERTISING, SALES PROMOTION & DISTRIBUTION

Characteristics, Impact, goals, types, Sales promotion-Point of Purchase, Unique Selling proposition.

Characteristics, Wholesaling, Retailing, channel design, logistics, Modern Trends inretailing.

7 Hours

Course Outcomes (CO):

At the end of the course the student will be able to

CO1	Explain the basic marketing concepts
CO2	Interpret the buying behaviour of customers and role of marketing segments
CO3	Explain the role of product pricing and marketing research in the competitiveglobal business environment
CO4	Analyse the marketing plans and strategies.
CO5	Explain the role of sales, advertising and distribution in marketing to achieve the goals ofmarketing

TEXTBOOK:

1. Govindarajan. M. 'Modern Marketing Management', Narosa Publishing House, NewDelhi, 1999

REFERENCE BOOKS:

1. Philip Kolter, " Marketing Management: Analysis, Planning, Implementation and Control ", 1998.
2. Green Paul.E. and Donald Tull, " Research for Marketing
3. Ramaswamy.V.S. and S.Namakumari, " Decisions ", 1975.
4. Jean Plerre Jannet Hubert D Hennessey Global Marketing, Environment: Planning, Implementation and Control the Indian Context ", 1990

NEXT GENERATION WIRELESS NETWORKS

Course Code	**21CC8X94**	**CIE Marks**	50
Number of Contact Hours/Week	**3:0:0**	**SEE Marks**	50
Total Number of Contact Hours	**39**	**Exam Hours**	03

Credits – 3

UNIT - I	**Contact Hours**
Historical Trend for Wireless Communication- Mobile Communications Generations: 1G to 4G – Evolution of LTE Technology to Beyond 4G – Pillars of 5G – Standardization Activities -Use cases and Requirements – System Concept **5G Architecture**: Software Defined Networking – Network Function Virtualization – Basics about RAN Architecture –High-Level Requirements for 5G Architecture – Functional Architecture and 5G Flexibility – Physical Architecture and 5G Deployment.	15
UNIT - II	
Massive Multiple-Input Multiple –Output Systems : MIMO in LTE – Single-user MIMO – Multi-user MIMO – Capacity of Massive MIMO – Pilot Design of Massive MIMO. **D2DCommunications**: from4Gto5G–Radio Resource Management for Mobile Broadband D2D–Multi-hop D2D Communications for Proximity and Emergency Services – Multi-operator D2D Communication.	15
UNIT – III	
Wi-Fi 6 Protocol and Network: Introduction Wi-Fi Generations 1 to 5 Overview Wi-Fi Generation 6 (802.11ax) Wi-Fi6 and 5G 60 GHz Wi-Fi , Introduction to 6G and Networks	9
<u>Course Outcomes:</u> Upon completion of this course, students will be able to: 1.Describe and explain the evolution of 5G, system concepts and spectrum challenges 2.Illustrate and explain the 5G functional and physical architecture and its requirements 3 Illustrate and explain the fundamentals, resource allocation and transceiver algorithms for Massive MIMO 4.Describe and explain the requirements and fundamental techniques for D2DCommunication 5. Understand, Implement, explain the Wi-Fi 6 Protocol and Network	
TEXTBOOKS: • Asif Oseiran, JoseF. Monserratand Patrick Marsch, "5GMobile and Wireless Communications Technology,"Cambridge University Press,2016 • Jonathan Rodriquez, "Fundamentalsof5GMobileNetworks," Wiley, 2015 Sundar Gandhi Sankaran, Susinder Rajan Gulasekaran, **Wi-Fi 6 Protocol and Network, Artech House, 2021**	
REFERENCE BOOK: • Patrick Marsch, Omer Bulakci, Olav Queseth and Mauro Boldi, "5G System Design – Architectural and Functional Considerations and Long Term Research", Wiley, 2018	

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INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Code	**21AI8X95**	**CIE Marks**	**50**
Number of Contact Hours/Week	**3:0:0**	**SEE Marks**	**50**
Total Number of Contact Hours	**40**	**Exam Hours**	**03**

Credits – 3

Course Learning Objectives:

This Course will enable students to:

1. Understand the history of AI and machine learning.
2. Learn principles and algorithms of supervised learning.
3. Explain various applications of Techniques in association analysis.
4. Use different unsupervised learning techniques to solve the problem specification.
5. Understand the methods of parametric and non-parametric methods on real time data analysis and combined learners.

UNIT – I	**Hours**
Introduction to AI: what is AI, Acting Humanly: The Turing Test approach, Thinking Humanly: The cognitive modelling approach, thinking rationally: The laws of thought approach, Acting Rationally: The rational agent approach. The state of art **Branches Of Artificial Intelligence:** Machine Learning, Deep Learning, Natural Language Processing, Robotics, Expert Systems, Fuzzy Logic. **Intelligent Agents:** Agents and Environments, Good behavior: The concept of rationality, The nature of environments, properties of task environments, Structure of Agents: Agent Programs, Types of agent programs. **Solving Problems by Searching:** Problem solving Agents, well defined problems and solutions, formulating problems, Example problems: Toy problems: Vacuum world, 8-Queen's problem, Real world problem: Airline Route finding problem **Textbook 1: Chapter 1, 2 ,3** **Foundations of Machine Learning** What is machine learning? Applications of Machine learning, Understand Data. **Types of machine learning:** Supervised, Unsupervised, Reinforcement Learning. **Supervised Learning:** Linear Regression: Introduction, univariate linear regression, multivariate linear regression, regularized regression, Logistic regression, Support Vector Machines. Artificial Neural Networks. **Textbook: Chapter 1 , 2.** **Classification:** Preliminaries; General approach to solving a classification problem; Confusion Matrix, Decision tree induction, how decision tree works, Hunt's algorithm, Design issues, Methods for expressing attribute test conditions, Measures for selecting best fit, Algorithm for decision tree induction; Rule-based classifier: How rule-based classifier works, Rule ordering schemes, Nearest-neighbor classifier: Selecting K value, KNN algorithm. **Textbook 3: Chapter 4, 5** Tutorials: 1. Handling the missing values using orange tool. 2. Visualize: Scatter Plot (for univariate), Scatter Plot Matrix (for multivariate) using orange tool. **3.** iris classification using different algorithm.	15

UNIT - II	
Unsupervised Learning: **Association Analysis–1:** Problem definition, Frequent item set generation, Apriori principle, Candidate generation and pruning, Rule Generation in Apriori algorithm. **Association Analysis – 2:** FP-Growth algorithm, Evaluation of association patterns, Effect of skewed support distribution, Sequential patterns. **Cluster Analysis:** Different types of clustering: Hierarchical vs partitional, Exclusive vs overlapping, Fuzzy clustering, Complete vs partial. Types of clusters: Well separated, Prototype based clusters, Graph based clusters, Density based clusters, Conceptual clusters, K-means clustering algorithm, centroids and objective functions, Choosing initial centroids, time space complexity of K-means, K-means additional issues, Strengths and weakness of k-means, Agglomerative hierarchical clustering,	15

Key issues in hierarchical clustering, Strengths and weaknesses, DBSCAN algorithm. **Textbook 3: Chapter 6, 7, 8, 9.** Tutorials: 1. Diabetes classification using orange tool. 2. Association analysis using orange tool. **3.** Trying different evaluation matrix using orange tool.	
UNIT – III	
Parametric Methods: Introduction, Maximum Likelihood Estimation, Bernoulli Density, Multinomial Density, Gaussian (Normal) Density, Evaluating an Estimator: Bias and Variance, The Bayes' Estimator, Parametric Classification **Nonparametric Methods**: Introduction, Nonparametric Density Estimation, Histogram Estimator, Kernel Estimator, k-Nearest Neighbor Estimator, Generalization to Multivariate Data, Nonparametric Classification, Condensed Nearest Neighbor. **Textbook 2: Chapter 4, 8.**	10
Course Outcomes: Upon completion of this course, students will be able to: 1. Basics of AI, branches of AI and ML. 2. Develop an appreciation for what is involved in learning models from supervised learning and algorithms on classification. 3. Apply association analysis on structured data. 4. Apply different unsupervised learning techniques to solve the problem specification. 5. Interpret methods of parametric and non-parametric methods on real time data analysis and know the combined learning.	
TEXTBOOKS: 1. Stuart Russel and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson 3rd Edition, 2016. 2. Introduction to Data Mining-Pang-NingTan, Michael Steinbach,Vipin Kumar, Pearson Education, 2009. 3. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, 2004.	
REFERENCE BOOKS: 1. T. M. Mitchell, "Machine Learning", McGraw Hill, 1997. 2. R. O. Duda, P. E. Hart and D. G. Stork Pattern Classification, Wiley Publications, 2001 3. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008. 4. P. Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge University Press, 2012. 5. K. P. Murphy, "Machine Learning: A probabilistic perspective", MIT Press, 2012. 6. M. Mohri, A. Rostamizadeh, and A. Talwalkar, "Foundations of Machine Learning", MIT Press, 2012. 7. S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall, 2009.	

MICRO AERIAL VEHICLES

Course Code	**21RI8X91**	**CIE Marks**	**50**
Teaching Hours/Week (L: T:P: S)	**(3:0:0:0)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**50**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**3**

Course Learning Objectives:

This Course will enable students to:

- Comprehend the basic aviation history and UAV systems.
- Acquire the knowledge of basic aerodynamics and performance.
- Understand the stability and control air vehicles
- Understand the propulsion, loads and structures.
- Develop and test the remote controlled, autonomous aerial vehicles

UNIT - I

Introduction Aviation History and Overview of UAV systems, Definitions and Terminology, **Classification of UAV's,** Classes and Missions of UAVs, UAV fundamentals, Examples of UAV systems-very small, small, Medium and Large UAV

The Air Vehicle

Basic Aerodynamics:

Basic Aerodynamics equations, Aircraft polar, the real wing and Airplane, Induced drag, the boundary layer, Flapping wings, Total Air-Vehicle Drag

Performance:

Overview, climbing flight, Range and Endurance – for propeller-driven aircraft, range- a jet-driven aircraft, Guiding Flight. **15 Hours**

Pedagogy	Chalk and talk, Power point presentation,

UNIT - II

Stability and Control

Overview, Stability, longitudinal, lateral, dynamic stability, Aerodynamics control, pitch control, lateral control, Autopilots, sensor, controller, actuator, airframe control, inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

Propulsion Overview, Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine, Electric Motors, and Sources of Electrical Power. Loads and Structures Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials, Resin Materials, Core Materials, Construction Techniques. **15 Hours**

Pedagogy	Chalk and talk, Power point presentation,

UNIT - III

Mission Planning and Control: Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads.

Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch and Recovery Trade-offs

9 Hours

Course outcome (Course Skill Set)

At the end of the course student will be able to

1. Explain the basics of aerodynamics performance and apply the basic concepts of UAV systems and experimentally study the integration of drones.
2. Explain the stability and control required for UAV and Select the propulsion system, materials for structures.
3. Develop and test remote controlled autonomous aerial vehicles. Experimental study on remote controlled and autonomous UAV.
4. Design air vehicles for different payloads and design standards. Experimental study on autonomous and remote-controlled Vertical Take-off and Landing UAV
5. Develop and test rotary wing aerial vehicles. Experimental study on Unmanned aerial vehicles and fixed wing UAV

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End

Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). CIE for Theory is for 50 marks and CIE for Lab component is 50marks. The final CIE for these IPCC courses is for 50 marks with 60% weightage of theory & 40% weightage of lab component CIE.

Theory Component	
MSE I	20 Marks
MSE II	20 Marks
Task-I	5 Marks
Task-II	5 Marks
Total	50 Marks

Semester End Examination:

There will be **8** questions of **20** marks each in the question paper divided into **3 Units** as per the syllabi & contact hours and the student will have to answer **5** full questions, selecting **2** full questions from **Unit - I** & **Unit – II** and **1** full question from **Unit – III**.

Suggested Learning Resources:

BOOKS:

1. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, Wiley Publication, 4th Edition,2012.
2. **Landen Rosen, Unmanned Aerial Vehicle, Alpha Editions**
3. Unmanned Aerial Vehicles: DOD's Acquisition, Alpha Editions
4. **Valavanis, Kimon P , Unmanned Aerial Vehicles , Springer, 2011**
5. Valavanis, K., Vachtsevanos, George J , Handbook of Unmanned Aerial Vehicles , Springer, 2015.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc22_me38/preview

COURSE ARTICULATION MATRIX:

Course Code / Name : / Micro Aerial Vehicles															
Course Outcomes (CO)	**Program Outcomes (PO)**												**PSO**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	3	2	1	-	-	-	-	-	-	-	-	-	2	-	2
	3	2	1	-	-	-	-	-	-	-	-	-	2	-	2
	3	2	1	-	-	-	-	-	-	-	-	-	2	-	2
	3	2	1	-	-	-	-	-	-	-	-	-	2	-	2
	3	2	1	-	-	-	-	-	-	-	-	-	2	-	2

1: 1ow 2: Medium 3: High

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SUSTAINABILITY ENGINEERING

Course Code:	**21CV8X96**	**CourseType:**	**OE**
Teaching Hours/Week (L:T:P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**39**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to:

1.	Understand the relevance, the concept and the role of engineers in sustainable development
2.	Understand green building concepts, materials, certifications, and sustainable practices through case studies in sustainability engineering.
3.	Master Life Cycle Assessment principles for environmental, social, and economic analysis in engineering applications.

4.	Enable students to understand and apply sustainability reporting frameworks like GRI, Dow Jones, and prepare comprehensive sustainability reports.
5.	Develop skills to integrate sustainability principles into civil engineering design processes, employing sustainable strategies and measuring sustainability effectively.

UNIT - I

Sustainable Development

Sustainable development- Need- various agreements and Role of Engineering- Sustainable Development and Engineering Profession. Sustainable Engineering concepts, Goals of Sustainability, System Thinking, Life cycle Thinking and circular economy

Green Building: Concept, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA) , leadership in energy and environmental design (LEED) rating, energy efficient buildings, sustainable cities, sustainable transport, sustainable pavements, case studies in sustainability engineering: Green building, sustainable city, sustainable transport system

15 Hours

UNIT - II

Fundamentals of Life Cycle Assessment

Energy systems, Buildings and the Built Environment, Life cycle inventory, Life Cycle Impact Assessment, Interpretation and presentation of Results, Iterative Nature of LCA, Methodological Choices, LCI Databases and LCA Softwares, Strength and Limitations of LCA. Environmental Life Cycle Costing, Social Life Cycle Assessment, Life Cycle Sustainability, **LCA Applications in Engineering:** Environmental Product Declarations and Product Category Rules, Carbon and Water Foot Printing,

Sustainability Reporting: GRI, Dow Jones Sustainability Index, Analysis and Research; Prerequisites of a sustainability Report, structure of a sustainability Report, Case Study: Sustainability Report Preparation.

15 Hours

UNIT - III

Integrating Sustainability in Civil Engineering Design:

Integrating Sustainability in Engineering Design: Problems Solving in Engineering, conventional to Sustainable Engineering Design Process, Design for Life Guidelines and Strategies, Measuring Sustainability, Sustainable Design through sustainable procurement criteria, Case studies on sustainable Engineering Design Process – Sustainable Process Design, Sustainable construction planning and Design, sustainable materials design in Civil Engineering.

09 Hours

Course Outcomes: At the end of the course students will

1.	Be proficient in applying sustainable engineering concepts, integrating system and life cycle thinking to address global challenges in the engineering profession.
2.	Adeptly apply green building principles, materials, certifications, and sustainability engineering case studies to contribute effectively to sustainable urban development.
3.	Master Life Cycle Assessment principles for comprehensive engineering analysis, integrating environmental, social, and economic dimensions effectively.
4.	skillfully prepare sustainability reports using GRI standards and Dow Jones Sustainability Index, applying theoretical knowledge to practical case studies for effective reporting.
5.	Adeptly integrate sustainability principles into civil engineering design, applying life cycle strategies and sustainable procurement criteria through case studies 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															
-1.1															
-1.2															
-1.3															
-1.4															
-1.5															

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Sreenivasan Sundarrajan, (2018). "Sustainable Development: Principles, Frameworks, and Practices", Springer
2.	S. S. Bhavikatti , (2016). "Sustainable Engineering: Concepts and Applications" Publisher: I.K. International Publishing House Pvt. Ltd.

3.	Gaurav Biswas, (2019). " Engineering Sustainable Communities: Principles and Practices ", CRC Press
4.	"Green Buildings Pay" by Brian W. Edwards (2013, TERI Press)
5.	"Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes" by Sam Kubba (2017, Butterworth-Heinemann)
6.	"Life Cycle Assessment: Theory and Practice" Bhupendra Kumar Sharma 2017 TERI Press
7.	"Life Cycle Assessment: Principles, Practice and Prospects" Author: R. K. Goel Publisher: TERI Press Year of Publication: 2017
8.	"Sustainability Reporting: GRI, Dow Jones Sustainability Index, Analysis and Research" Author: Zabihollah Rezaee Publishing Year: 2017 Publisher: John Wiley & Sons
9.	"Sustainable Engineering: Concepts, Design and Case Studies" by David T. Allen, 2019, Wiley.
E Books / MOOCs/ NPTEL	
1.	https://onlinecourses.nptel.ac.in/noc24_de01/preview; Strategies for Sustainable Design.
2.	https://onlinecourses.nptel.ac.in/noc24_hs77/preview; Energy Resources, Economics, and Sustainability;