CURRICULUM & SYLLABI
2023-24

(AS PER NEP 2020)

B.TECH. IN ELECTRICAL ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING
FACULTY OF ENGINEERING & TECHNOLOGY
JAMIA MILLIA ISLAMIA
NEW DELHI-110025

www.jmi.ac.in/electrical

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION OF THE DEPARTMENT

To produce comprehensively trained socially responsible, innovative electrical engineers and researchers of highest quality to contribute to the nation's imprint on the world stage.

MISSION OF THE DEPARTMENT

M1 Department is committed to provide world class teaching, mentoring with intellectual stimulation.

M2 Department is committed to industry collaboration and state of the art research.

M3 Department is committed to outreach program to address societal and industrial needs.

SNAPSHOTS OF CURRICULUM REVSION WORKSHOP AS PER NEP 2020

ONE DAY WORKSHOP ON CURRICULUM & SYLLABUS REVISION OF

B.TECH (ELECTRICAL ENGINEERING)

AS PER NEP 2020 GUIDELINES

21 February 2024
10:00 AM - 5:00 PM

Prof. Mini Shaji Thomas
(Dean)

Prof. Shahida Khatoon
(Head of the Department)

Prof. Haroon Ashfaq
(Coordinator)

DEPARTMENT OF ELECTRICAL ENGINEERING
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SNAPSHOTS OF CURRICULUM REVSION WORKSHOP AS PER NEP 2020

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MESSAGE OF THE DEAN, FET

It is with great pride and anticipation that I present the Curriculum and Syllabus Booklet for B.Tech Electrical Engineering, crafted in line with the principles and objectives of the National Education Policy (NEP) 2020. This revised curriculum is designed to reflect the dynamic nature of modern education, with an emphasis on flexibility, interdisciplinary learning, and fostering a deeper understanding of the rapidly evolving technological landscape in electrical engineering. To achieve the objectives of NEP 2020, the students are given the option to choose a Honours degree in specialized courses of the same department or Minor degree in specialized courses of other departments of FET. I extend my gratitude to all who are involved in the curriculum and syllabus revision and the booklet.

The NEP 2020 emphasizes the need for a more inclusive, innovative, and practical approach to education, and this booklet embodies those ideals. We have worked diligently to ensure that the updated syllabus not only meets the academic requirements but also provides our students with the necessary skills to thrive in a technology-driven world. The curriculum integrates advanced learning techniques, industry-relevant content, and hands-on experience, empowering students to develop into well-rounded engineers. I encourage both our faculty and students to engage actively with this revised curriculum to fully realize its potential and contribute to the growth and progress of the electrical engineering field.

Warm Regards,

[Prof. Mini Shaji Thomas]
Dean, Faculty of Engineering and Technology, Jamia Millia Islamia

MESSAGE OF THE HEAD OF THE DEPARTMENT

II am pleased to present the Curriculum and Syllabus Booklet for B.Tech Electrical Engineering, designed in accordance with the transformative goals outlined in the National Education Policy (NEP) 2020. This booklet is the result of extensive deliberations, feedback, and collaboration among stakeholders, industry experts, and academic leaders done through the curriculum and syllabus revision workshop held on 21st February 2024. It marks a significant step towards aligning our educational practices with global standards, while also addressing the evolving needs of the electrical engineering field.

The revised curriculum emphasises flexibility, innovation, and interdisciplinary learning, with a strong focus on enhancing practical skills, critical thinking, and creativity. By integrating emerging technologies and fostering a more holistic approach to education, we aim to prepare our students not only for the demands of the engineering profession but also for the dynamic, ever-changing challenges of the future. I hope this booklet serves as a valuable guide for both faculty and students as we continue to strive for excellence and work together to build a robust and future-ready electrical engineering program.

Warm Regards,

[Prof. Shahida Khatoon]
Head of the Department
Electrical Engineering

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PREFACE

In line with the National Education Policy (NEP), the Department of Electrical Engineering at JAMIA MILLIA ISLAMIA, New Delhi, acknowledges the dynamic nature of technology in our field, which necessitates constant updating of content and resources. Recognizing this imperative, the department has undertaken the task of redesigning, developing, and enhancing its previous curriculum and syllabus.

This booklet serves to present the revised course structure, detailed syllabi, internal assessment criteria, and marks distribution for the B. Tech. Programmes offered by the Department of Electrical Engineering.

The revamped curriculum aligns with the norms set by the All India Council for Technical Education (AICTE) and the University Grants Commission (UGC), while also encompassing syllabi relevant to competitive exams conducted by esteemed bodies such as UPSC, NTPC, Power Grid, BHEL, and GATE. Core courses in electrical engineering are supplemented by elective courses in emerging fields, allowing students to specialize in their chosen areas of interest. Furthermore, significant emphasis has been placed on foundational courses in basic sciences, humanities, and engineering.

The primary objective of this curriculum overhaul is to instill confidence in students within the realm of electrical engineering. The syllabus has been meticulously crafted to cover all fundamental aspects of electrical engineering education in accordance with national and international standards.

Recent advancements such as Electric Vehicles, Artificial Intelligence, Machine Learning, Internet of Things, Energy Economics, Grid Integration of Renewable Energy, etc. have been integrated into the syllabi to ensure students are abreast of the latest developments in the field.

The department underscores the importance of self-directed learning, facilitating avenues for tutorials, seminars, field visits, and industrial training components. Practical training in laboratories and interactive classroom sessions complement theoretical instruction, providing a holistic learning experience for students.

This booklet is the culmination of the Workshop on Curriculum Revision for B. Tech. Course held on February 21, 2024. Gratitude is extended to all faculty members for their unwavering dedication throughout the course revision process.

It is our sincere hope that this booklet proves invaluable to all B. Tech. students within the Electrical Engineering Department at Jamia Millia Islamia, aiding them in their academic endeavors and beyond.

(Prof. Shahida Khatoon)
Head

JAMIA MILLIA ISLAMIA

Jamia Millia Islamia, a Public Central University; established in 1920, originally at Aligarh in United Provinces which in 1925 initially moved to Karol Bagh, Delhi and later built up in Jamia Nagar. In 1988, it became the Central University by an Act of Parliament and since then it is expanding in different directions achieving the new dimensions.

The University is the result of the tireless efforts of its founders i.e. Shaikhul Hind Maulana Mahmud Hasan, Maulana Muhammad Ali Jauhar, Hakim Ajmal Khan, Dr. Mukhtar Ahmad Ansari, Jenab Abdul Majeed Khwaja and Dr. Zakir Husain. It symbolizes the unflinching and resolute commitment of these great visionaries in bringing about socio-economic transformation of common masses in general and Muslims in particular, through the vehicle of education. The distinct identity of Jamia Millia Islamia has been eloquently explicated by Dr. Zakir Husain Sahib.

Jamia Millia Islamia is basically originated as the movement of a struggle for education and cultural renaissance against the colonial regime and evolves a national culture for common Indian. Its foundation is to promote patriotism and national integration among Indians, who will be proud to take part in the future progress of India, which will play its part in the comity of nations for peace and development and to prepare the children of masses in general and Muslims in particular, to be the masters of the future in different subjects/disciplines of their choice.

The mission of the founding fathers of this great institution should not only serve as a beacon light for all the stakeholders, but should also inspire all in making this university as one of the premier institutions of higher learning in the world. It should attain distinction in providing cutting edge learning experience, internationally benchmarked education, intellectual freedom and critical research opportunities in frontier areas of contemporary concern.

Today, Jamia Millia Islamia is accredited A++ grade Central University by NAAC during the 2nd cycle in December 2021. It achieved 3rd Rank in University Category-2022 in NIRF India Rankings. The university is an ensemble of a multi- layered educational system which covers all aspects of schooling, under-graduate and post-graduate education.

The university recognizes that teaching and research are complementary activities that can advance its long-term interest. It has Sciences, Life Sciences, Social Sciences, Engineering & Technology, Education, Humanities & Languages, Architecture & Ekistics, Fine Arts, Law, Dentistry and Management Studies Faculties. Also, it has a well-known AJK Mass Communication Research Centre. Jamia has over thirty research Centres that have given it an edge in terms of critical research in various areas.

JAMIA MILLIA ISLAMIA

Dr. Syedna Mufaddal Saifuddin

Amir-e-Jamia (Chancellor)

Prof. Mazhar Asif

Shaikh-ul-Jamia (Vice Chancellor)

Prof. Md Mahtab Alam Rizvi

Musajjil (Registrar)

Prof. Mini Shaji Thomas

Dean, Faculty of Engineering and Technology

Prof. Shahida Khatoon

Head, Department of Electrical Engineering

OFFICERS OF JAMIA MILLIA ISLAMIA

Amir-e-Jamia (Chancellor)	Dr. Syedna Mufaddal Saifuddin
Shaikh-ul-Jamia (Vice Chancellor)	Prof. Mazhar Asif
Musajjil (Registrar)	Prof. Md Mahtab Alam Rizvi
Finance Officer (Offg.)	CA Shaikh Safiullah
Controller of Examinations (Offg.)	Prof. Saroj Kumar Mahananda
Chief Proctor	Prof. Naved Jamal
Dean, Students' Welfare	Prof. Neelofer Afzal
Dean, Faculty of Humanities and Languages)	Prof. Iqtidar Mohd. Khan
Dean, Faculty of Social Sciences	Prof. Mohd. Muslim Khan
Dean, Faculty of Sciences	Prof. Saeed Uddin
Dean, Faculty of Education	Prof. Sara Begum
Dean, Faculty of Engineering and Technology	Prof. Mini Shaji Thomas
Dean, Faculty of Law	Prof. Kahkashan Y. Danyal
Dean, Faculty of Architecture and Ekistics	Prof. Qamar Irshad
Dean, Faculty of Dentistry	Dr. Keya Sircar
Dean, Faculty of Fine Arts	Prof. Bindulika Sharma
Dean, Faculty of Management Studies	Prof. Amirul Hasan Ansari
Dean, Faculty of Life Sciences	Prof. Mohammad Zahid Ashraf

FACULTY OF ENGINEERING & TECHNOLOGY

Faculty of Engineering & Technology, Jamia Millia Islamia, established in 1985, has distinguished itself as a leading knowledge hub for technical minds. With its bright students from across the country, able Faculty members and up-to-date research infrastructure, the Faculty of Engineering & Technology has been able to produce excellent graduates for the service of the Nation. Our graduates are gainfully employed in Government services, reputed corporate houses and high ranked educational Institutions globally.

The Faculty is home to over 2000 students and over 200 academic, administrative, and technical staff. There are seven departments, namely – Civil, Mechanical, Electrical, Electronics & Communication, Computer Engineering, Environmental Sciences and Applied Sciences & Humanities and all the departments offer PG and PhD programs along with 5 UG programs in the five fields of engineering. The University Polytechnics also a part of the Faculty of Engineering and Technology with 2000 + students.

The FET has more than 100 faculty members who are engaged in research, in emerging areas of Smart grid, Deep learning, Artificial Intelligence, Advanced Manufacturing, Smart materials, 5G communications, Geotechnical and Environmental Engineering, etc, and are carrying out many research projects & consultancies in these areas. This gives the students, a glimpse of the emerging areas, coupled with regular revision of the curriculum in consultation with industry experts, alumni and academicians makes the students Industry ready.
At Jamia Millia Islamia, it is our endeavour to develop the students as rounded individuals and all efforts are made to ensure participation of the students in co-curricular activities on a regular basis and the campus has the student chapters of reputed international societies such as IEEE, ASME, ASCE, SAE, TRS, ISTE etc. Students are encouraged to excel in extracurricular activities.

Departments of the Faculty:

- Department of Civil Engineering
- Department of Mechanical Engineering
- Department of Electrical Engineering
- Department of Applied Sciences & Humanities
- Department of Electronics & Communication Engineering
- Department of Computer Engineering
- University Polytechnic
- Department of Environmental Science

FACULTY OF ENGINEERING & TECHNOLOGY

PROGRAMMES OF STUDY

The Faculty offers the following Programmes.

1. UNDERGRADUATE PROGRAMMES

Bachelor of Technology (8 Semesters)

- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Electronics & Communication Engineering
- Computer Engineering

2. POSTGRADUATE PROGRAMMES

- M. Tech. Environmental Science & Engineering
- M. Tech. Environmental Science & Engineering (Part Time)
- M. Tech. Earthquake Engineering
- M. Tech. Mechanical Engineering
- M. Tech. Electrical Power System & Management Engineering
- M. Tech. Control & Instrumentation Systems Engineering
- M. Tech. Electronics & Communication Engineering
- M. Tech. Computer Engineering
- M. Tech. Energy Science (Full Time) SFS
- M. Tech. Computational mathematics (SFS)
- M. Sc. Environmental Science & Management
- M. Sc. Environmental Science & Management (SFS)

3. DOCTOR OF PHILOSOPHY

- Offered by all departments

4. DIPLOMA PROGRAMS (6 semesters) (University Polytechnic)

- Three year Diploma in Civil, Mechanical, Electrical, Electronics & Communication, Computer Engineering,

DEPARTMENT OF ELECTRICAL ENGINEERING

The Department of Electrical Engineering at the Faculty of Engineering & Technology of Jamia Millia Islamia, New Delhi is one of the premier electrical engineering education and research departments of the Country and is also one of the SAP departments of UGC as well as a FIST supported department. Since its inception in 1985 along with the inception of Faculty of Engineering & Technology of Jamia Millia Islamia, New Delhi, it has grown leaps and bounds and continuously striving for excellence.

Apart from offering regular four-year under graduate programmes,, the department has been serving to the specialised needs of the industry by running two regular M. Tech. Programs. One in Electrical Power Systems Management (EPSM) which started in 2003-04 and another in Control and Instrumentation Systems (CIS) which started in 2012. The Department of Electrical Engineering has been successfully achieving its research endeavours through its very well structured and disciplined Ph. D. programme in seven major areas, i.e. Power Systems; Power Electronics and Electrical Machines; Control and Instrumentation; Computer Science & Technology; Electronics & Communication and; Biomedical Engineering; Dental Sciences & Technology; Medical Sciences & Technology. Admission of the students in each programme is highly competitive and is through Joint Entrance Examination conducted by NTA for B.Tech. and national level entrance exam for M.Tech. as well as Ph.D.

The department is respectfully recognized at national and international platforms through its accomplished alumni, research publications and representation of its dedicated faculty members as invited speakers, delegates, subject experts, reputed journal reviewers, members of expert committees and elected fellows of national/international professional societies. The department is committed to grow further as a socially responsible and research oriented centre of learning.

The faculty members at Department of Electrical Engineering lead by examples and are highly motivated to achieve excellence in research and development and publish their research in internationally peer reviewed journals, patenting their research findings, and bringing generous research grants from Govt. research funding agencies like DRDO, DST, AICTE, MHRD, MNRE, UGC, DOE, BARC etc. to upgrade the research facilities at the department and to provide innovative solutions to engineering problems. Many faculty members have received prestigious national and international awards for their contributions. The Department is also one of the recognized QIP centre under the engineering discipline. Number of Ph.Ds awarded under various research areas from the department till date is more than 150. The h-index of the Department is 57.

ABOUT THE PROGRAM

B.TECH. (ELECTRICAL ENGINEERING)

The profession of electrical engineering demands a strong foundation in physical science and mathematics, a broad knowledge of engineering techniques, and an understanding of the relation between technology and society. Curricula in Department of Electrical Engineering are planned to offer the breadth of education and depth of training necessary for leadership in the profession. The Department of Electrical Engineering offers a regular four year B.Tech in Electrical Engineering program with intake of 70.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1 Successful electrical engineering graduates will be able to pursue diverse range of career as electrical engineer, as consultant and as entrepreneur.

PEO2 Successful electrical engineering graduates will be able to acquire, apply and develop expertise as required for higher education and research & development.

PEO3 Successful electrical engineering graduates will be able to address social issues including environmental and ethical challenges with proper communication skills.

PEO4 Successful electrical engineering graduates will be engaged in lifelong learning to remain abreast in their profession and be leaders in our technologically vibrant society.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1 The graduates will be able to resolve and provide solutions to the challenges in the fields of Power Generation, Transmission and Distribution.

PSO2 The graduates will acquire skills in the area of Instrumentation & Control.

PSO3 The graduates will be able to solve problems related to Power Electronics and Electric Drives.

CURRICULUM AND SYLLABUS REVISION COMMITTEE

CURRICULUM AND SYLLABUS REVISION COMMITTEE FOR B.TECH. (ELECTRICAL ENGINEERING) AS PER NEP-2020

As per the National Education Policy (NEP) 2020, the Curriculum and Syllabus Revision Committee for B.Tech Electrical Engineering is tasked with ensuring that the educational content remains relevant, up-to-date, and aligned with industry standards and emerging technological trends. Therefore, this committee revised the curriculum structure and course contents in line with the AICTE model curriculum, syllabus of competitive examinations such as GATE and IES, and indutry needs. The committee focused on revising the curriculum to incorporate a multidisciplinary approach, integrating both theoretical knowledge and practical skills. It aims to ensure that students are well-prepared to meet the evolving demands of the electrical engineering field, with an emphasis on innovation, critical thinking, and problem-solving abilities.

The committee worked towards making the curriculum more flexible, allowing students to choose electives from various disciplines and gain exposure to subjects that are complementary to electrical engineering, such as robotics and automation, cyber security, and grid protection. In line with NEP 2020's vision of promoting a holistic education, the revised syllabus will encourage experiential learning, project-based assessments, and industry collaborations, thereby fostering a more comprehensive and future-oriented learning experience for B.Tech Electrical Engineering students.

Curriculum and Syllabus Revision Committee Members

Chairman	Prof. Ibraheem
Member	Prof. Shakeb Ahmad Khan

WORKSHOP ON CURRICULUM AND SYLLABUS

WORKSHOP ON CURRICULUM AND SYLLABUS REVISION OF B.TECH. (ELECTRICAL ENGINEERING) AS PER NEP-2020

The Workshop on Curriculum and Syllabus Revision for B.Tech Electrical Engineering held on 21st February 2024, as per the guidelines set by NEP 2020, serves as a collaborative platform to bring together academic experts, industry professionals, and educators to discuss and design a more contemporary and industry-relevant curriculum. The workshop focuses on aligning the current curriculum with the goals of NEP 2020, which emphasizes flexibility, innovation, and the integration of interdisciplinary learning. It aims to revise the syllabus to ensure that students are equipped with not only technical knowledge but also the essential skills such as critical thinking, creativity, and problem-solving abilities, which are vital in the fast-evolving field of electrical engineering. The curriculum and course content is revised in line with the AICTE model curriculum, syllabus of competitive examinations such as GATE and IES, and indutry needs.

The workshop provides an opportunity for stakeholders to review existing course structures, identify gaps, and incorporate modern trends and technologies like renewable energy, smart grids, and automation. It also emphasizes the need for a practical approach to learning, with an increased focus on hands-on training, industry internships, and project-based learning. The committee will explore strategies to include more flexibility in the curriculum, such as allowing students to choose electives from related fields like computer science, robotics, or data analytics, enabling them to develop a broader skill set. Additionally, the workshop aims to foster collaboration between academia and the industry, ensuring that the revised curriculum reflects the latest advancements and prepares students for real-world challenges in the electrical engineering domain.

Workshop Committee

Chief Coordinator	Prof. Shahida Khatoon, HoD
Coordinator	Prof. Haroon Ashfaq
Convener	Dr. Md Sarwar

WORKSHOP ON CURRICULUM AND SYLLABUS

WORKSHOP ON CURRICULUM AND SYLLABUS REVISION OF B.TECH. (ELECTRICAL ENGINEERING) AS PER NEP-2020

Subject Groups

I. Power System

Experts	Prof. T. S. Bhatti, Centre for Energy studies, IIT Delhi
	Mr. Raghavendra Singh, Senior DGM, PGCIL, Bahadurgarh
Group Coordinator	Prof. Anwar Shahzad Siddiqui
Faculty Members	Prof. Ibraheem, Prof. Mini Shaji Thomas Prof. Majid Jamil Prof. Ikbal Ali Ms. Farhat Nasim

II. Power Electronics and Electrical Machines

Experts	Dr. Shahid Malik, Centre for Sensors, IIT Delhi
	Mr. Anand Kumar, AGM (Electrical), Airport Authority of India, New Delhi
Group Coordinator	Prof. Haroon Ashfaq
Faculty Members	Dr. Ahteshamul Haque Dr. Rajveer Singh Dr. Abrar Ahmed Dr. Md Sarwar

II. Control and Instrumentation

Experts	Prof. Smriti Srivastava, Department of Instrumentation and Control Engineering, NSUT, Delhi
	Mr. R. B. Mirza, Managing Director, Losung Automation Pvt Ltd., Mahipalpur New Delhi
Group Coordinator	Prof. Shakeb Ahmad Khan
Faculty Members	Prof. Shahida Khatoon Dr. Arunesh Kumar Singh Dr. Kashif I. K. Sherwani

WORKSHOP ON CURRICULUM AND SYLLABUS

IV. Electronics & Communication

Experts	Prof. Ekram Khan, Department of Electronics Engineering, Aligarh Muslim University, Aligarh (U.P)
	Mr. Sunil Kumar Rawat, IRRS, Ministry of Communication, New Delhi
Group Coordinator	Prof. Zainul A. Jaffery
Faculty Members	Prof. A. Q. Ansari Prof. Tarikul Islam Dr. Md Muzammil Sani

V. Computer Technology & Miscellaneous

Experts	Prof. D. K. Tayal, Department of Computer Science and Engineering, Indira Gandhi Delhi Technical University for Women, Delhi
	Mr. Mayank, Scientist 'E', Ministry of Electronics and Information Technology (MeitY), New Delhi
Group Coordinator	Prof. Shabana Mehfuz
Faculty Members	Prof. Manaullah Prof. Munna Khan Dr. Md Muzammil Sani

ORDINANCE 15-C (XV-C) ACADEMICS "EXAMINATION"

Bachelor of Technology (B.Tech.)

Notwithstanding anything contained to the contrary, the following Ordinances shall apply to the B.Tech. programme of the Faculty of Engineering & Technology under the Semester System.

1. The degree of Bachelor of Technology (B.Tech.) shall be awarded to candidates who have successfully undergone at this University, a regular program of study of minimum four academic years (eight semester) in the relevant branch of Engineering and who satisfy other academic requirements as specified by the Academic Council from time to time.

2. Evaluation

A course may be a theory course or a practical course (including project, seminar, field work, industrial training etc.). A course will carry a specified number of credits decided by the concerned Board of Studies. Each credit will be equivalent to 25 marks.

(a) In each semester, for each prescribed theory course there shall be a Mid Semester Evaluation and an End Semester Examination.

(b) The Mid Semester Evaluation shall have a weightage of 40% while the remaining 60% weightage will be for End Semester Examination.

(c) The marks in respect of the Mid Semester Evaluation of a course shall be notified by the Head of the Department Concerned before the commencement of the End Semester Examination. The Mid Semester Evaluation (40%) shall comprise the following:

(i) 30% for two mid semester tests, both of equal weightage;

(ii) 10% for other modes of sessional evaluation (to be specified by the Faculty Committee and notified before the commencement of teaching of each course).

3. A student has to secure at least 40% marks in each component (i.e. Mid Semester Evaluation and End Semester Examination) in order to pass the course. In order to be eligible to appear in the End Semester Examination of a Particular course, a student must get the required minimum of 40% marks in the Mid Semester Evaluation of that course.

4. There will be no Mid Semester practical tests. In a practical course/ project/ seminar/ industrial training/ field work, the End Semester Examination shall have a weightage of 40% while the performance of the student as evaluated by the teacher concerned during the semester (i.e. Mid Semester Evaluation) shall have a weightage of 60%.

5. The marks of each course shall be the combined marks obtained by the students in the Mid Semester Evaluation and the End Semester Examination.

Promotion

6. If a student is detained due to shortage of attendance in any semester, he/she will not be promoted to the next semester. He/she will also be detained for the subsequent semester. Thereafter he/she will become a regular student of the same semester in which he/she was detained. As a regular student, he/she will appear in the mid semester test as well as the End Semester Examination.

7. (a) Every student shall be promoted from an odd semester to the next even semester except those detained due to shortage of attendance (as in clause 6 above).

   (b) A student will be promoted from an even semester to the next odd semester (except those detained due to shortage of attendance as in clause 6 above), provided the total number of his/her uncleared credits does not exceed 18.

8. A student who is not promoted as in 7 (b) above; due to uncleared courses exceeding 18 credits, will be detained for a whole year and will appear (as an ex-student) in the End Semester Examinations of all his/her uncleared courses (held in that year, in both semesters). He/she may, however be permitted to attend classes of the uncleared courses, with the permission of the Head of the Department. However, he/she will have to reappear in the Mid Semester Evaluation of only those courses in which he / she could not secure the required minimum of 40% marks (specified in clause 3).

9. A promoted student will not appear in the Mid Semester Evaluation of uncleared courses, provided he/she had obtained the required minimum of 40% marks in the Mid Semester Evaluation of that course. The marks obtained by him/her in the Mid Semester Evaluation (as a regular student) will remain valid.

Use of unfair means

10. (a) If the result of a student is cancelled on account of using unfair means, his/her previous Mid Semester Evaluation marks shall remain valid and will be taken into account for the award of grades whenever he/she is subsequently permitted to appear in the End Semester Examination.

    (b) The cases of students resorting to unfair means shall be referred to the Examination Committee.

11. **Re-evaluation**

    There shall be no re-evaluation in any B.Tech. (Semester System) Courses.

12. **Compartmental Examinations**

    Compartmental examinations will be held only for regular students, in the theory courses of VII & VIII semesters, after the declaration of VIII semester results.

13. **Maximum Time Limit**

    No student shall be allowed to appear in the examination after the expiry of seven annual academic sessions including the one in which he/she was first admitted to the Bachelor of Technology programme.

14. **Attendance**

The provisions of the University Ordinance-35 (Academic) in this respect shall be applicable.

15. **Letter Grades**

The Letter Grades will be awarded in each course on the basis of the combined marks obtained by the student in the two components of evaluations (Mid Semester Evaluation and End Semester Examination) mentioned in Clauses 3 and 4. Letter grades on 10-Point Scale will be awarded as described here in below. On obtaining a pass grade, the student will be supposed to have earned the credits assigned to the course and no chance for improvement of this grade shall be provided.

16. **Grading**

16.1 A letter grade shall be awarded in each course and on obtaining a pass grade O, A+, A, B+, B, C+ or C the student shall be supposed to have earned the credits assigned to the course.

16.2 The combined marks obtained by a student in two components of evaluation (Mid Semester Evaluation & End Semester Examinations) of a course shall be the basis of award of letter grades (O, A+, A, B+, B, C+, C and F) on 10-Point Scale in accordance with the table given below:

GRADING SYSTEM			
GRADE	**RANGE OF MARKS ($M^{\#}$)**	**GRADE POINT (G)**	**SIGNIFICANCE**
O	$90 \leq M \leq 100$	10	Outstanding
A+	$80 \leq M < 90$	9	Excellent
A	$70 \leq M < 80$	8	Very Good
B+	$60 \leq M < 70$	7	Good
B	$50 \leq M < 60$	6	Average
C+	$45 \leq M < 50$	5	Below Average
C	$40 \leq M < 45$	4	Minimum Passing Grade
F	$M < 40$	0	Fail

$M^{\#}$: Marks obtained by a student on the 100-point scale

17. **Submission of Grade Award List**

The Grade Award list of a course shall be prepared by the teacher(s) concerned in triplicate and shall be submitted along with evaluated answer scripts (if any) for tabulation of results.

18. **Semester Performance Index (SPI)**

It is the weighted average of the grade points of all courses during the semester and shall be calculated as follows:

$$\text{SPI} = \frac{\sum (\text{Credits assigned to a course}) \times (\text{Numerical value of the grade awarded})}{\sum \text{Credits}}$$

$$= \frac{\sum C_i W_i}{\sum C_i}$$

where the sum run over all courses of that semester.

19. **Cumulative Performance Index (CPI)**

The final CPI (Cumulative Performance Index) of a student shall be calculated on a base of 10 and shall be on the basis of the candidate's performance, spread over the first year, the second year, the third year and the fourth (Final) year of Bachelor of Technology Programme. The relative weightage assigned to each of the four years shall be as follows.

(i) The first year	25% (of the sum of SPI of I and II Semesters)
(ii) The second year	50% (of the sum of SPI of III and IV Semesters)
(iii) The third year	75% (of the sum of SPI of V and VI Semesters)
(iv) The fourth (Final) year	100% (of the sum of SPI of VII and VIII Semester)

where SPI (Semester Performance Index) will be calculated according to the provision given in Clause 18 herein above.

20. **Division**

The Division will be awarded in the following manner (with maximum CPI of 10 as base):

I Division with Honours	$CPI \geq 8.5$
I Division	$6.5 \leq CPI < 8.5$
II Division	$CPI < 6.5$

21. **Conversion Formula of Cumulative Performance Index (CPI)**

For the purpose of conversion of CPI after Final Year B.Tech. Examination into an equivalent Percentage of Aggregate marks (Y %) the following formula may be used:

$Y\ \% = 137.4 - 44.24X + 6.96X^2 - 0.29X^3$

Where, X = CPI

Updated Vide E.C. Resolution No. EC-2016 (II):3.51, dated: 28.06.2016;
Notification No. 03/L&O/RO/JMI/2016, dated: 26.08.2016

Ordinance 35 (XXXV) (Academic)

ATTENDANCE

(for Regular Students)

1. In order to be eligible to appear at the Annual/Semester End Examination, a student shall be deemed to have undergone a regular course of study (except M.Ed. Course) in the University, if he/she has attended at least 75% in lectures/tutorials, AND separately 75% in practicals/ field work/teaching practice and/or such other activities as decided by the Academic Council from time to time.

Provided that a relaxation to the maximum extent of 10% of the total attendance may be accorded to a student on account of serious sickness/excruciating medical disability*, participation in the university-approved co-curricular/extra-curricular activities and prescribed educational/cultural tours.

Provided further that in case of medical disability as mentioned herein above, an application for condonation shall be supported by a medical certificate advising such a condonation issued by a Public Hospital or such hospitals as notified by Jarnia Millia Islamia (as per the appended annexure). The University may, at its discretion, refer such cases to the Ansari Health Centre of Jamia. The decision of the medical experts of the Ansari Health Centre shall be final and conclusive. ***Such applications must be submitted either during the period of treatment/hospitalization or within two weeks following recovery.*** In case of review/rejection by the Ansari Health Centre, the same shall be communicated to the applicant by the concerned department *vithin two weeks* of receipt of application for condonation.

For M. Ed. Course, the minimum attendance of students shall be 80% for Theory Courses and Practicum, and 90% for Field Attachment.

2.** In the case of B.A. LL.B. (Hons.) programme, in terms of the requirements of the Bar Council of India, no student shall be allowed to take the End-Semester Examination in a subject if the student concerned has not attended a minimum of 70% of the classes held in the subject as also in the 'moot court', room exercises, tutorials and practical training conducted in the subject taken together.

Provided that if a student for any exceptional reason(s) fails to attend 70% of the classes as mentioned herein above, a committee set up by the Vice-Chancellor, on the recommendation of the Dean of the Faculty, may examine the

case and submit its recommendation to the Vice-Chancellor to allow/ disallow the student to take the examination if the student concerned attended at least 65% of the classes held in the subject concerned and attended 70% of the classes in all the subjects taken together.

3. In the case of B.D.S. programme, a student shall be required to satisfy the following requirements pertaining to attendance:

(a) No student shall be permitted to appear in the annual examination unless he/she has fulfilled all the requirements of the course and has secured not less than 75% attendance in theory and 75% in practical and clinical, individually in all subjects.

(b) In case of a subject in which there is no examination at the end of the academic year, the percentage of attendance shall not he less than 70% in theory/ practical/ clinical individually. However, at the time of appearing for the University Examination in those subjects, the aggregate percentage of attendance in each subject should satisfy the condition (a) above.

4. Notwithstanding anything contained in the Paras 1-3, a Faculty/Department/Centre, as it may deem fit, may include certain other components of the programme/courses like agency placement, conferences, self development modules, camps, training and other allied activities for regulating attendance, as approved by the Academic Council from time to time on the recommendation of the concerned Board of Studies/ Committee of Studies.

Provided that the attendance requirements in the components of such programme of study/ courses shall in no way be less than 75%.

5. In consonance with these Ordinances, the University may frame regulations for effective implementation of the rules pertaining to attendance.

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* Serious sickness/ excruciating medical disability shall include all diseased conditions requiring hospitalization or such diseases that render immobility for the period duly certified by the State Government/Central Government hospitals/dispensaries and all such hospitals that have been empanelled by Jamia Millia Islamia as per the C.G.H.S. rules.

** Paras 2 and 3 are as per the regulations of the Bar Council of India and Dental Council of India, respectively.

E.C. Resolution No. 2013(VII):3.24, dated : 29.8.2013
Notification No. JMI/R.O./L&Ord./2013,dated : 11.10.2013

Regulation R-35 (R-XXXV) *(academic)*
Counting of Attendance of Students

1. Subject to the provisions laid down in Ordinance 35 (academic), the attendance of students, who have registered themselves in various programmes/courses of study, shall be computed as per the procedure described in this Regulation.

2. Attendance of students admitted to the 1st semester/ 1st year of any programme/course of study shall be counted from the date of admission in the respective classes.

3. Classes of the consecutive semesters/years shall commence from the 1st working day after the summer/winter vacations and all students who have been/are likely to be promoted to the next semester/year of the class will be deemed to have been given 'provisional' admission, even if the examination results of such students are awaited or they have not completed their re-admission. The attendance of all such provisionally admitted students shall be counted from the 1st working day of the respective semester/year.

   Provided that in the Bachelor of Dental Surgery (B.D.S.) course where there is a provision of 'supplementary examination' as per the ordinance of the said course, if a student passes the supplementary examination, his/her attendance shall be counted from the date of his/her provisional admission. However, if a student fails in the supplementary examination, his/her attendance shall be counted from the date of his/her re-admission to the previous class, which he/she has been reverted back.

   Provided further that the provisionally admitted students shall be required to complete their re-admission by 31st of July of each year or within 15 days of the declaration of result, whichever is latter. In case the student is unable to complete the re-admission as per the above time limit, he/she will be allowed to complete the re-admission within the next 15 days after the expiry of the cut-off date with the provision of late payment of such fees as is notified from time to time.

   Provided further that if a student fails to complete his/her re-admission by the above extended schedule of late payment of fee, his/her admission shall stand cancelled.

4. If a student is found to be continuously absent from classes without information (communicated in writing with valid cause the reason for such absence) for a period as specified in Para No. 2.7 of Ordinance 14 [academic], his/her name shall be struck of the rolls of the University.

   Such a student may, however, be readmitted only after getting approval of the Vice-Chancellor as provided in the above-mentioned Ordinance

5. The late submission of fee by a readmitted student will not entitle him/her for any relaxation in attendance and that his/her attendance shall be computed from the date of commencement of classes.

E.C. Resolution No. 2014(I):3.11, dated : 3.3.2014
Notification No. JMI/R.O./L&Ord./2014, dated : 29.04.2014

Ordinance 37 (XXXVII) [Academic]
Transfer of Credit

1) This Ordinance is aimed at providing a framework for promoting and facilitating the Inter-university transfer and mobility of students across different Universities of India and abroad that can work well.

2) This Ordinance is aimed at prescribing:
   a) procedure for facilitating and promoting transfer of credits earned by the students of this University to other Universities/educational institutions; and
   b) policy framework, procedure and conditions for accepting transfer of credits earned by a student from other Universities/educational institutions.

Facilitation for Transfer of Credits to other Universities/educational institutions:

3) The University shall facilitate transfer of credits earned by its students to other Universities/ educational institutions.

4) A student of the University seeking transfer of credit to other Universities/ institutions shall submit a written request, along with the fee as prescribed by the Academic Council from time to time, to the Controller of Examinations.

5) The Controller of Examinations, upon receipt of such request, shall issue a complete transcript of the Courses taken by the student in the University and shall forward the same along with the application of the students to the University/institution concerned.

Policy and Procedure for accepting Credit Transfer from other Universities

6) The University shall have a policy of accepting transfer of credits earned by a student from the following Universities/educational institutions/research institutions:
   a) Universities recognised under Section 12(b) of the UGC Act.
   b) Universities that are members of the Association of Indian Universities.
   c) Such foreign Universities, the Courses/Programmes of which are recognised as equivalent to those of Indian Universities by the Association of Indian Universities.
   d) Indian Institutes of Technology (IIT)
   e) Indian Institutes of Management (IIM)

f) National Institutes of Technology (NIT)

g) Indian Institutes of Science Education and Research (IISER)

h) Indian Institutes of Information Technology (IIIT)

i) Schools of Planning and Architecture (SPA)

j) All India Institute of Medical Sciences (AIIMS)

k) Such Indian or Foreign University/educational institution/research institution with which the University has signed an MOU for students and faculty exchange.

l) Any other University/educational institution/ research institution that has been recognised and approved for the purpose of credit transfer by the Academic Council of the University.

7) Request for acceptance of transfer of credits shall be:

a) entertained only if received from such candidates w~o have been duly selected for admission in a Programme of Studies, as per the rules governing admission in the University;

b) made by the student concerned within 10 days from the date of his/her admission in the University.

c) made in the prescribed format and along with the fees as prescribed by the Academic Council of the University from time to time.

d) supported by such documents as may be prescribed by the Academic Council.

8) Dean of the Faculty concerned shall be the Nodal Officer for receiving and processing the request for accepting the transfer of credits. To facilitate and expedite the process, the Dean may constitute a Committee comprising a senior faculty as chairperson and two faculty members to process and finalize the request for acceptance of credit.

9) The maximum credits that can be accepted for transfer shall not exceed 25% of the total credits required for the completion of the Programme of Studies in which a student has been admitted.

10) Only such Courses may be considered for acceptance of credit transfer, in which the student has secured at least B grade/ GPA of 2 or above/ a minimum of 50% marks, as the case may be. In case a student has earned more credits from other Universities/educational institutions/research institutions, the student may indicate his/her preference for credit transfer. However, the decision of the Dean of the Faculty concerned in this regard shall be considered as final.

11) The credit equivalence for accepting credit transfer shall be determined as under:

a) for credit(s) earned by students from Universities that have the credit system in place, a Course work requiring 15 hours of contact hours shall be considered as equivalent to 1 credit of the University;

b) for Courses completed from Universities/educational institutions/research institutions that do not follow credit system but have semester system in place, a course work requiring a minimum 30 lecture hours per semester shall be considered as equivalent to 2 credits of the University; and

c) for Courses completed from Universities/educational institutions/research institutions that neither follow the credit system nor have the semester system, a Course work requiring formal classroom instruction/lab work of at least 2 hours per week it shall be considered as equivalent to 2 credits of the University.

d) In case of any difficulty in determining the equivalence, the cases may be referred to the Standing Committee for Equivalence of Courses for Credit Transfer

12) The University may also permit its students to accumulate certain credits from other Universities/ educational institutions/research institutions in full or partial fulfilment of the required Course work. In such cases:

a) the student shall be required to obtain prior approval of the Dean of the School;

b) the Courses can be undertaken only in the institutions specified in para 8 above; and

13) the maximum number of credits that can be accumulated by a student from other institutions shall not exceed 25% of the total credits prescribed for the successful completion of the Programme of Studies.

Standing Committee for Equivalence for Recognition of Courses for Credit Transfer

14) There shall be a Standing Committee constituted by the University to facilitate credit transfer to and from universities/institutions that have/have not yet adopted the credit system. The composition of the Committee shall be the following:

i) Pro-Vice-Chancellor or One of the Deans to be nominated by the Vice-Chancellor who shall be the Chairman;

ii) Deans of the Faculties;

iii) One academician to be nominated by the Vice-Chancellor from amongst the Professors of the University for a period of three years;

iv) Registrar;

v) Controller of Examinations - Member-Secretary.

At least one-third of the members of the Committee shall constitute the quorum for a meeting of the Committee.

The functions of the Committee shall be as under:

a) To consider proposals from other universities/institutions with regard to transfer of credits;
b) To consider proposals and for the recognition of courses taken by a student from other universities/institutions for which the request for credit transfer has been received from the student;
c) To determine and approve the number and extent of credits that may accepted/permitted for credit transfer on case by case basis;
d) To report to the Academic Council on all matters concerning credit transfer, which are referred to the Committee.

16) All proposals and requests for equivalence of courses shall first be examined by the Dean of the Faculty/Director of the Centre concerned with regard to the courses of study and the standard of the course.

17) The recommendation of the Dean/Director shall be placed before the Standing Committee for Equivalence of Courses for Credit Transfer.

B.TECH. (ELECTRICAL ENGINEERING) CURRICULUM AS PER NEP 2020

EFFECTIVE FROM JULY 2023

Abbreviations

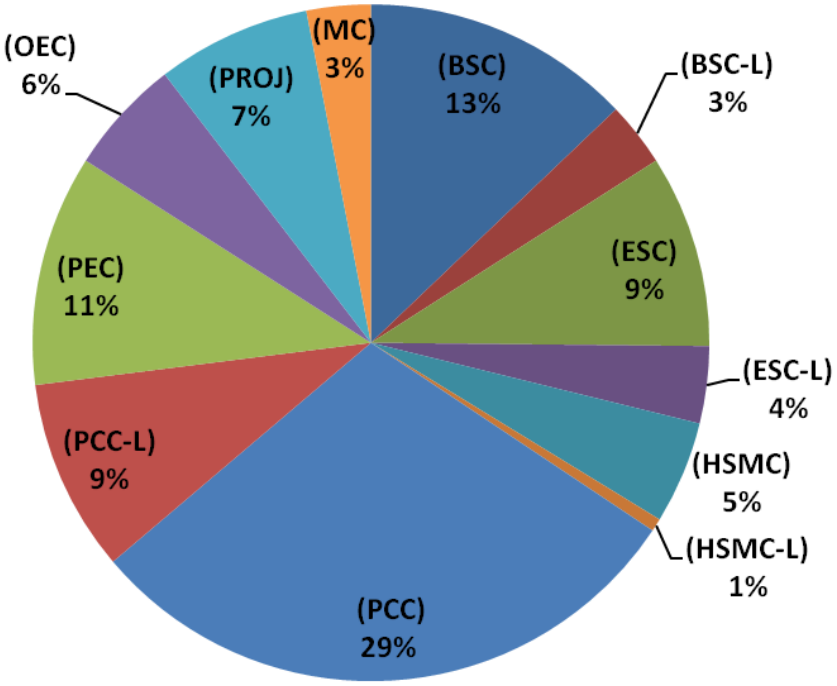
BSC	Basic Science Course
BSC-L	Basic Science- Laboratory Course
ESC	Engineering Science Course
ESC-L	Engineering Science-Laboratory Course
HSMC	Humanities, Social Sciences including Management Courses
HSMC-L	Humanities, Social Sciences including Management Courses
PCC	Professional core course
PCC-L	Professional core courses- Laboratory Course
PEC	Professional Electives courses
OEC	Open Electives course
PROJ	Seminar/ Internship/ Minor Project/ Major Project
MC	Mandatory Course
HDC	Honors Degree Course
HDC-L	Honors Degree Course- Laboratory Course
MDC	Minor Degree Course
MDC-L	Minor Degree Course- Laboratory Course
CCA	Continuous Class Assessment
MSE	Mid Semester Evaluation
ESE	End Semester Evaluation
L	Lecture
T	Tutorial
P	Practical

Breakup of Courses

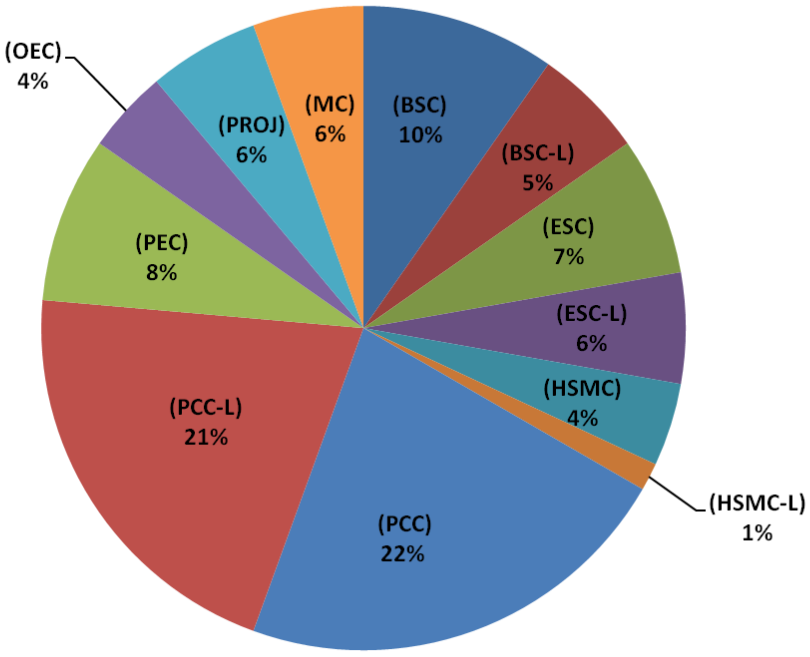
S. No.	Courses	Credits								Total	No. of Courses
		1st Year		2nd Year		3rd Year		4th Year			
		1st Sem.	2nd Sem.	3rd Sem.	4th Sem.	5th Sem.	6th Sem.	7th Sem.	8th Sem.		
1	Basic Science Course **(BSC)**	9	9	3						21	7
2	Basic Science- Laboratory Course (**BSC-L**)	4	1							5	4
3	Engineering Science Course (**ESC**)	6	9							15	5
4	Engineering Science-Laboratory Course (**ESC-L**)	1	3		2					6	4
5	Humanities, Social Sciences including Management Courses (**HSMC**)	2			6					8	3
6	Humanities, Social Sciences including Management Courses (**HSMC-L**)	1								1	1
7	Professional core courses (**PCC**)			12	9	15	12			48	16
8	Professional core courses-Laboratory Course (**PCC-L**)			4	3	4	4			15	15
9	Professional Electives courses (**PEC**)					3	3	12		18	6
10	Open Electives courses (**OEC**)							3	6	9	3
11	Seminar/ Internship/ Minor Project/ Major Project (**PROJ**)						1	2+3	6	12	4
12	Mandatory Course (**MC**)		0	3	2					5	4
	Total	23	22	22	22	22	20	20	12	163	72

COURSES DETAILS

Creditwise Breakup of Courses of Different Categories



Categorywise Breakup of Courses



BSC	Basic Science Course
BSC-L	Basic Science- Laboratory Course
ESC	Engineering Science Course
ESC-L	Engineering Science- Laboratory Course
HSMC	Humanities, Social Sciences including Management Courses
HSMC-L	Humanities, Social Sciences including Management Courses
PCC	Professional core courses
PCC-L	Professional core courses- Laboratory Course
PEC	Professional Electives courses
OEC	Open Electives courses
PROJ	Seminar/ Internship/ Minor Project/ Major Project
MC	Mandatory Courses

B.TECH. ELECTRICAL ENGINEERING–I YEAR

First Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	AST-101	Communication Skills	HSMC	2	2	0	0	2	5	15	30	50
2.	ASB-101	Engineering Physics I	BSC	3	2	1	0	3	8	22	45	75
3.	ASB-102	Engineering Chemistry	BSC	3	2	1	0	3	8	22	45	75
4.	ASB-103	Engineering Mathematics I	BSC	3	2	1	0	3	8	22	45	75
5.	CSS-101	Fundamentals of Computing	ESC	3	2	1	0	3	8	22	45	75
6.	EES-101	Basics of Electrical Engineering	ESC	3	2	1	0	3	8	22	45	75
i.	ASL-101	Language Laboratory	HSMC-L	1	0	0	2	2	15	-	10	25
ii.	ASL-102	Engineering Physics Laboratory I	BSC-L	1	0	0	2	2	15	-	10	25
iii.	ASL-103	Engineering Chemistry Laboratory	BSC-L	1	0	0	2	2	15	-	10	25
iv.	MEL-104	Engineering Graphics & Design	BSC-L	2	0	0	4	4	30	-	20	50
v.	ASL-104	Design Thinking & Idea Lab	ESC-L	1	0	0	2	2	15	-	10	25
			Total	**23**				**29**				

Second Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	ASB-201	Engineering Physics II	BSC	3	2	1	0	3	8	22	45	75
2.	ASB-202	Engineering Mathematics II	BSC	3	2	1	0	3	8	22	45	75
3.	ASB-203	Biology for Engineers	BSC	3	3	0	0	3	8	22	45	75
4.	ECS-201	Basics of Electronics & Communication Engineering	ESC	3	3	0	0	3	8	22	45	75
5.	MES-201	Basics of Mechanical Engineering	ESC	3	3	0	0	3	8	22	45	75
6.	CES-201	Basics of Civil Engineering	ESC	3	3	0	0	3	8	22	45	75
7.	ASM-201	Mandatory Course: Constitution of India	MC-I (Audit)	0	2	0	0	2	-	-	-	-
i.	ASL-201	Engineering Physics Laboratory II	BSC-L	1	0	0	2	2	15	-	10	25
ii.	MEL-201	Workshop Practice	ESC-L	2	0	0	4	4	30	-	20	20
iii.	MEL-202	Engineering Mechanics Laboratory	ESC-L	1	0	0	2	2	15	-	10	25
			Total	**22**				**28**				

B.TECH. ELECTRICAL ENGINEERING–II YEAR

Third Semester

. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	EEC-301	Electronics Devices and Circuits	PCC	3	2.5	0.5	-	3	8	22	45	75
2.	EEC-302	Network Analysis	PCC	3	2.5	0.5	-	3	8	22	45	75
3.	EEC-303	Signals and Systems	PCC	3	2.5	0.5	-	3	8	22	45	75
4.	EEC-304	Transformer and Induction Machine	PCC	3	2.5	0.5	-	3	8	22	45	75
5.	ASB-301	Engineering Mathematics-III (Probability and Statistics)	BSC	3	2.5	0.5	-	3	8	22	45	75
6.	ASM-301	Mandatory Course: Universal Human Values	MC-II	3	3	-	-	3	8	22	45	75
7.	ASM-302	Mandatory Course: Essence of Indian Traditional Knowledge	MC-VI (Audit)	0	2	0	0	2	-	-	-	-
i.	EEL-301	Electronics Devices and Circuits Lab.	PCC-L	1	-	-	2	2	15	-	10	50
ii.	EEL-302	Network Analysis Lab.	PCC-L	1	-	-	2	2	15	-	10	25
iii.	EEL-303	Signals and System Lab	PCC-L	1	-	-	2	2	15	-	10	25
iv.	EEL-304	Transformer and Induction Machine Lab.	PCC-L	1	-	-	2	2	15	-	10	25
			Total	**22**				**28**				

Fourth Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	EEC-401	DC and Synchronous Machines	PCC	3	2.5	0.5	-	3	8	22	45	75
2.	EEC-402	Digital Electronics	PCC	3	2.5	0.5	-	3	8	22	45	75
3.	EEC-403	Power Electronics	PCC	3	2.5	0.5	-	3	8	22	45	75
4.	ASM-401	Mandatory Course: Environmental Science	MC-III	2	2	-	-	2	5	15	30	50
5.	AST-40x	Open Elective-I: AST-401: Operations Research	HSMC	3	3	-	-	3	8	22	45	75
6.	AST-40x	Open Elective-II: AST-402: Engineering Economics	HSMC	3	3	-	-	3	8	22	45	75
i.	EEL-401	DC and Synchronous Machine Lab.	PCC-L	1	-	-	2	2	15	-	10	25
ii.	EEL-402	Digital Electronics Lab	PCC-L	1	-	-	2	2	15	-	10	25
iii.	EEL-403	Power Electronics Lab.	PCC-L	1	-	-	2	2	15	-	10	25
iv.	ASL-401	Numeric and Scientific Computing Lab.	ECS-L	2	-	-	4	4	30	-	20	50
			Total	**22**				**27**				

B.TECH.ELECTRICAL ENGINEERING–III YEAR

Fifth Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	EEC-501	Control Systems	PCC	3	2.5	0.5	-	3	8	22	45	75
2.	EEC-502	Switchgear and Protection	PCC	3	2.5	0.5	-	3	8	22	45	75
3.	EEC-503	Electrical Measurement	PCC	3	2.5	0.5	-	3	8	22	45	75
4.	EEC-504	Programming Languages	PCC	3	2.5	0.5	-	3	8	22	45	75
5.	EEC-505	Fundamentals of Power Systems	PCC	3	2.5	0.5	-	3	8	22	45	75
6	EEE-50x	***Professional Elective courses-I*** EEE-501: Communication Systems/ EEE-502: Programmable logic controller/ EEE-503: Electromagnetic Field Theory/ EEE-504: Utilization of Electrical Energy/ EEE-505: Data Structures and Algorithms/ EEE-508: Computer Architecture/ EEE-510: Digital Signal Processing/ EEE-511: Introduction to Robotics	PEC	3	3	-	-	3	8	22	45	75
i.	EEL-501	Control Systems Lab.	PCC-L	1	-	-	2	2	15	-	10	25
ii.	EEL-502	Switchgear and Protection Lab.	PCC-L	1	-	-	2	2	15	-	10	25
iii.	EEL-504	Programming Languages lab	PCC-L	1	-	-	2	2	15	-	10	25
iv.	EEL-505	Power Systems Communication Lab	PCC-L	1	-	-	2	2	15	-	10	25
			Total	**22**				**26**				

Sixth Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	EEC-601	Advanced Control System	PCC	3	2.5	0.5	-	3	8	22	45	75
2.	EEC-602	Electrical and Electronics Instrumentation	PCC	3	2.5	0.5	-	3	8	22	45	75
3.	EEC-603	Power Systems Analysis	PCC	3	2.5	0.5	-	3	8	22	45	75
4.	EEC-604	SCADA and Smart Grid Technologies	PCC	3	2.5	0.5	-	3	8	22	45	75
5.	EEE-60x	***Professional Elective courses-II*** EEE-601: Microprocessor and Microcontroller / EEE-602: HVDC Transmission / EEE-603: Electrical Power Generation/ EEE-604: Robotics and Artificial Intelligence	PEC	3	3	-	-	3	8	22	45	75
i.	EEL-602	Electrical Measurement & Instrumentation Lab.	PCC-L	1	-	-	2	2	15	-	10	25
ii.	EEL-603	Power Systems Analysis (MATLAB Based)	PCC-L	1	-	-	2	2	15	-	10	25
iii.	EEL-604	SCADA and Smart Grid Technologies Lab	PCC-L	1	-	-	2	2	15	-	10	25
iv.	EEL-605	Microprocessor and Microcontroller Lab.	PCC-L	1	-	-	2	2	15	-	10	25
v.	EEP-601	Seminar (Literature Review)	PROJ-I	1	-	-	2	2	15	-	10	25
			Total	**20**				**24**				

B.TECH. ELECTRICAL ENGINEERING–IV YEAR

Seventh Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	EEE-70x	***Professional Electives courses-III*** EEE-701: Power System Operation and Control/ EEE-702: Embedded Systems	PEC	3	3	-	-	3	8	22	45	75
2.	EEE-70x	***Professional Electives courses –IV*** EEE-703: Data Communications and Computer Networks/ EEE-704: Advanced Protective Relays	PEC	3	3	-	-	3	8	22	45	75
3.	EEE-70x	***Professional Electives courses –V*** EEE-705:Electric drives/ EEE-706: VLSI Design	PEC	3	3	-	-	3	8	22	45	75
4.	EEE-70x	***Professional Electives courses –VI*** EE-707: Bio-Medical Instrumentation/ EEE-708: Electrical Machine Design	PEC	3	3	-	-	3	8	22	45	75
5.	EEO-70x	***Open Elective-III*** EEO-701: Advance Power Electronics/ EEO-705: Cyber Physical Systems	OEC	3	3	-	-	3	8	22	45	75
i.	EEP-701	Summer Internship*	PROJ-II	2	-	-	4	4	30	-	20	50
ii.	EEP-702	Minor Project	PROJ-III	3	-	-	6	6	45	-	30	75
			Total	**20**				**25**				

***During last summer vacation (Minimum 6-8weeks)**

Eighth Semester

S. No	Course No.	Course Name	Course Type	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
					L	T	P		CCA	MSE	ESE	Total
1.	EEO-80x	***Open Elective-IV*** *(SWAYAM/NPTEL/MOOCs)/* EEO-801: High Voltage Engineering/ EEO-802: Grid Protection and Control/ EEO-803: Mechatronics	OEC	3	3	-	-	3	8	22	45	75
2.	EEO-80x	***Open Elective-V*** *(SWAYAM/NPTEL/MOOCs)/* EEO-804: Soft Computing/ EEO-805: Electricity Markets & Regulations	OEC	3	3	-	-	3	8	22	45	75
i.	EEP-801	Major Project	PROJ-IV	6	-	-	12	12	90	-	60	150
			Total	**12**	**06**	**0**	**12**	**18**				

***In case of semester long project work done in industry or internship, the OECs in VIII semester may be offered in online mode/NPTEL or SWAYAM. The examination scheme/distribution of marks of courses offered through NPTEL/SWAYAM/MOOCs will be as per NPTEL/SWAYAM/MOOCs**

	Semesters								
Total	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits**
	23	22	24	22	21	19	20	12	**163**
	Additional course required for Honours Degree OR Minor Specializations								
	-	-	-	3	3	4	5	3	**18**
								Total	**181**

Department Courses for Honours Degree and Minor Degree Specialization

Honours Degree Specialization 1: Control & Automation

S. No	Course No.	Course Name	Course Type	Semester	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
						L	T	P		CCA	MSE	ESE	Total
1.	EEH-411	Special Electrical Machines	HDC	**IV**	3	3	-	3	3	8	22	45	75
2.	EEH -511	Electric Vehicle & EMS	HDC	**V**	3	3	-	3	3	8	22	45	75
3.	EEH -611	Robotics and Automation	HDC	**VI**	3	3	-	3	3	8	22	45	75
i	EEL-621	Robotics and Automation Lab	HDC-L	**VI**	1	-	-	2	2	15	-	10	25
4.	EEH -711	IoT & Transducer Technology	HDC	**VII**	3	3	-	3	3	8	22	45	75
ii	EEP-713	Project	PROJ	**VII**	2	-	-	4	4	30	-	20	50
5.	EEH-811	Advanced Robotics/ (SWAYAM/ NPTEL/MOOCs)	HDC	**VIII**	3	3	-	3	3	8	22	45	75
			Total		**18**				**21**				

Honours Degree Specialization 2: AI & Cyber Security

S. No	Course No.	Course Name	Course Type	Semester	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
						L	T	P		CCA	MSE	ESE	Total
1.	EEH-412	Introduction to Computer Networks & Cyber Security	HDC	**IV**	3	3	-	3	3	8	22	45	75
2.	EEH -512	Introduction to AI & Machine Learning	HDC	**V**	3	3	-	3	3	8	22	45	75
3.	EEH -612	Deep Learning & ANN	HDC	**VI**	3	3	-	3	3	8	22	45	75
i	EEL-622	Deep Learning Lab	HDC-L	**VI**	1	-	-	2	2	15	-	10	25
4.	EEH -712	Cryptography & Network Security	HDC	**VII**	3	3	-	3	3	8	22	45	75
ii	EEP-713	Project	PROJ	**VII**	2	-	-	4	4	30	-	20	50
5.	EEH-81x	EEH-812: Natural Language Processing EEH-813:Deep Learning for Computer Vision/ (SWAYAM/ NPTEL/MOOCs)	HDC	**VIII**	3	3	-	3	3	8	22	45	75
			Total		**18**				**21**				

Honours Degree Specialization 3: Energy and Grid Technology

S. No	Course No.	Course Name	Course Type	Semester	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
						L	T	P		CCA	MSE	ESE	Total
1.	EEH-413	Energy Conservation and Management	HDC	**IV**	3	3	-	3	3	8	22	45	75
2.	EEH -513	Energy Economics and Auditing	HDC	**V**	3	3	-	3	3	8	22	45	75
3.	EEH -613	Renewable Energy Resource Characteristics	HDC	**VI**	3	3	-	3	3	8	22	45	75
i	EEL-623	Grid Technology Lab	HDC-L	**VI**	1	-	-	2	2	15	-	10	25
4.	EEH -713	Grid Integration of Renewable Energy	HDC	**VII**	3	3	-	3	3	8	22	45	75
ii.	EEP-713	Project	PROJ	**VII**	2	-	-	4	4	30	-	20	50
5.	EEH-814	Distributed Generation and Microgrid Technologies/ (SWAYAM/ NPTEL/MOOCs)	HDC	**VIII**	3	3	-	3	3	8	22	45	75
			Total		**18**				**21**				

Minor Degree Specialization in Electric Vehicle and Automation

S. No	Course No.	Course Name	Course Type	Semester	Credits	Periods per week			Hours per week	Examination Scheme (Distribution of Marks)			
						L	T	P		CCA	MSE	ESE	Total
1.	EED-411	Power Electronics for Electric Vehicles	MDC	**IV**	3	3	-	3	3	8	22	45	75
2.	EED -511	Electric Vehicle Control Systems	MDC	**V**	3	3	-	3	3	8	22	45	75
3.	EED -611	Electric Vehicle Energy Systems	MDC	**VI**	3	3	-	3	3	8	22	45	75
i	EEL-624	Electric Vehicle Lab	MDC-L	**VI**	1	-	-	2	2	15	-	10	25
4.	EED -711	Electric Vehicle Drives	MDC	**VII**	3	3	-	3	3	8	22	45	75
ii.	EEP-713	Project	PROJ	**VII**	2	-	-	4	4	30	-	20	50
5.	EED-81x	EED-811: AI and ML Application in EV/ EED-812: Electric Vehicle Advance Technologies and Economics/ (SWAYAM NPTEL/MOOCs)	MDC	**VIII**	3	3	-	3	3	8	22	45	75
			Total		**18**				**21**				

FIRST SEMESTER COURSES

AST-101: COMMUNICATION SKILLS

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	0	0	2	Mid Sem.40%+ End Sem.60% =100%	HSMC	30

Pedagogy: Classrooms lecture, Group discussion etc.

Pre requisites: Should know basic circuit analysis

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Gain proficiency in English
CO2	Develop personality, communication fluency & accuracy
CO3	Inculcate ideation and exposition skills
CO4	Hone the interpretative, logical, creative and imaginative skills.
CO5	Create human sensibilities and forge convergences of technology with larger humanity.

Unit- I: Communication Skills and its various aspects:
Communication Skills: theoretical perspectives. Reading, Writing, Listening, Speaking and Pragmatics, Identification of Communication Barriers and ways to overcome them, Technology, Humanities & Communication

Unit-II: Grammar:
Subject-verb agreement, Use of tense & sequence of tenses, Use of verbs, repositions & articles, Use of idioms & phrases, Discourse markers, Word vocabulary- synonym, antonym, homonym & one word substitution

Unit-III: Writing:
Formal & informal letters & Email correspondences, Report, Resume, Reviews (Book & Scientific) & Expansion, Essay & Article writing

Unit IV: English Phonetics:
Speech Mechanism, Organs of Speech, Vowels & Consonants, Place of Articulations, Manner of Articulation, Vowel diagram, IPA symbols, Phonetic Transcription, Word , tress (Primary Accent)

Unit V: Literature:
Road Not Taken (Poem by Robert Frost), The Express (Poem by Stephan Spender), Of Studies (Essay by Francis Bacon), Pygmalion (by George Barnard Shaw)

TEXT BOOKS:

1. The Joy of Reading: Orient Blackswan Pvt. Ltd, New Delhi
2. Fluency in English: Macmillan Publishers, New Delhi
3. Intermediate Grammar Usage and Composition : M.L.Tikoo and Subramanian , Orient Blackswan Pvt. Ltd, New Delhi
4. A Text Book of English Phonetics for Indian Students: T. Balasubramanian, Macmillan Publishers, New Delhi.
5. Practical English Usage: Michael Swan, Oxford University Press.

REFERENCES BOOKS:

1. The Oxford Guide to effective Writing and Speaking Skills: John Seely, Oxford University Press
2. English Pronouncing Dictionary: Daniel Jones, Cambridge University Press.
3. Technical communication Principles and Practice: Meenakshi Raman and Sangeeta Sharma, Oxford

ASB-101: ENGINEERING PHYSICS – I

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	1	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be

CO1	Enhancing the concept of conservative and non conservative force.
CO2	Understanding the concept of coordinate system and different type of integration.
CO3	Developing a comprehensive understanding of electric and magnetic fields, their relation and practical applications.
CO4	Apply quantum ideas to explain the behavior of materials at quantum level.
CO5	Understanding the physics of solids.

UNIT- I: CLASSICAL MECHANICS:
Review of Newtonian Mechanics in rectilinear Coordinate system, Rigid body, Translational and Rotational motion, Moment of Inertia, Radius of Gyration, Kinematics of rotational motion about fixed axis (Parallel axis theorem Perpendicular axis theorem), Simple harmonic motion (SHM), phaser representation of SHM, Simple Pendulum and Compound Pendulum, Damped harmonic oscillator- heavy, critical and light damping, energy decay in damped harmonic oscillator, quality factor.

UNIT –II: ELECTROSTATICS:
Coordinate Systems: Cartesian, Cylindrical and Spherical, Transformation of coordinate systems, Gradient of a scalar, divergence and curl of a vector; line integral, surface integral and volume integral, Divergence Theorem, Stokes Theorem, Charge distribution(line, surface and volume), Gauss's law and its applications(Electric field due to cylinder, infinite sheet, spherical shell),

UNIT- III: MAGNETOSTATICS:
Bio-Savart law and its application, Gauss`s law in magneto statics, Displacement current, Ampere`s circuital law and its application, Equation of Continuity. Working and principle of Potentiometer, Wheatstone bridge.

UNIT-IV: QUANTUM IDEAS:
Prerequisite of Quantum theory, Black body radiation, Planck`s hypothesis, wave particle duality; Photoelectric effect; de-Broglie hypothesis; Experimental evidence of matter waves (Davisson-Germer experiment), Compton effect, Uncertainty principle and its applications.

UNIT-V: SOLID STATE PHYSICS:
Classical free electron theory of metals and its failure, Concept of electrical conductivity, thermal conductivity, Weidmann Franz Law, Bose Einstein and Fermi Dirac statistical distribution function, Fermi energy of free electron in metal, concept of average energy and total energy of free electrons, relation between average energy and Fermi energy, Basic of semiconductors, Bragg`s Law and X-ray diffraction.

TEXT BOOKS:
1. Fundamentals of Physics: Halliday and Resnick
2. Introduction to Electrodynamics: David J. Griffiths
3. Optics: Ajoy Ghatak
4. Concepts of Modern Physics: Arthur Beiser

REFERENCES BOOKS:
1. Elements of Electrodynamics, Mathew N. O. Sadiku
2. Electricity, magnetism and Light, W. Saslow
3. Fundamentals of Optics, Jenkins and White

ASB-102: ENGINEERING CHEMISTRY

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	1	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOME: After the completion of the course, the students will be able

CO1	Understand basics of material science and surfactants.
CO2	Understand the fundamentals of instrumental methods of analysis.
CO3	Study and understand about chemical methods of analysis and phase rule.
CO4	Develop an understanding of basics of electrochemistry.
CO5	Understand about the fundamentals of polymers.

UNIT-I: BASICS OF MATERIAL SCIENCE AND SURFACTANTS:
Types of crystal system, Bravais lattices, Miller indices, Atomic packing factor, Planar atomic density, Crystal defects. Surface active agents: Soaps, Types and advantages. Detergents, Critical Micellar Concentration, Hydrophilic and Hydrophobic interactions, HLB values.

UNIT-II: INSTRUMENTAL METHODS OF ANALYSIS:
Chromatography: Definition and its types, Adsorption chromatography, Partition chromatography, High Pressure Liquid Chromatography. Fundamentals of Spectroscopy: Principles and Applications of UV-Visible, Infra-Red and Atomic Absorption Spectrometry.

UNIT-III: CHEMICAL METHODS OF ANALYSIS AND PHASE RULE:
Gravimetric Analysis: Digestion and its Importance, Favorable Conditions for Precipitation. Volumetric Methods of Analysis: Expression of concentration of solutions, Redox, Precipitation and Complexometric Titrations. Phase Rule and its applications to One and Multiple Component systems.

UNIT - IV: ELECTROCHEMISTRY:
Reversible and Irreversible cell: Electrolytic and Galvanic cell, Electrode Potential, Standard Electrode Potential, EMF series, Nernst Equation, Cell emf Measurement. Thermodynamic Overview of Electrochemical Processes. Conductance, Cell Constant and its determination.

UNIT - V: POLYMERS:
Fundamentals of polymer chemistry: Molecular weight, Glass transition temperature and Melting point. Methods of polymerization, Structure-property relationship, Thermoplastics and Thermosets. Fabrication of polymers by Compression, Injection, Extrusion and Transfer Moulding. Synthesis, properties and uses of common polymers , Conducting polymers and their applications.

TEXT BOOKS:

1. V. Raghvan, “Material Science and Engineering: A first Course”, Prentice Hall, 2006.
2. Jain and Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company.
3. Satyaprakash & Manisha Agrawal, “Engineering Chemistry”, Khanna Book Publishing, Delhi.
4. V. R. Gowarikar: “Polymer science”, New age international Publishers.

REFERENCES BOOKS:

1. William D. Callister, Jr and David G. Rethwisch, Materials Science and Engineering: An Introduction, 10th Edition, Wiley, USA
2. Colin N. Banwell and Elaine M. McCash, Fundamentals of Molecular Spectroscopy, McGraw Hill Book Company Europe, England
3. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel’s Textbook of Quantitative Chemical Analysis, John Wiley and Sons
4. Atkins, P.W.; Paula, J.de. (2014),Atkin’s Physical Chemistry Ed., 10th Edition, Oxford University Press.
5. Robert J. Young and Peter A. Lovell, Introduction to Polymers, CRC Press, Taylor & Francis

ASB-103: ENGINEERING MATHEMATICS – I

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	I	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to perform

CO1	Successive differentiation, expansion of functions, partial derivatives, double points and asymptotes.
CO2	Tracing of curve of two-dimensional, curvature, quadrature, rectification, volume and surface area of solids of revolutions.
CO3	Theory of two variable Calculus, Eigen values, Eigen vectors, consistency of system, vector space and linear transformations.
CO4	Solution of ordinary differential equations with its applications.
CO5	Learning the concepts of partial differential equations.

Unit –I: CALCULUS OF ONE VARIABLE AND ITS APPLICATIONS:
Successive differentiation (Leibnitz's theorem of nth derivative), Maclaurin's and Taylor's expansion of a function; Double point and its nature; Concavity, convexity and points of inflexion; Oblique and rectangular asymptotes, Curve tracing (Cartesian and polar forms), Curvature, Radius of curvature (Cartesian and polar forms)

Unit –II: CALCULUS OF SEVERAL VARIABLES AND ITS APPLICATIONS:
Partial derivatives and their geometrical interpretation, Total derivative, change ofvariables, Euler's Theorem on Homogeneous Function, Taylor's expansion of a function of two and more variables; Leibnitz's rule for differentiation under the sign of integration; Maxima and minima of a function of two and more variables including Lagrange's method.

Unit- III: INTEGRATION AND ITS APPLICATIONS:
Beta and Gamma Functions, Evaluation of multiple integrals by change of order of integration, applications of multiple integrals(Rectification, Volume and Surface of revolution)

Unit- IV: ORDINARY DIFFRENTIAL EOUATIONS AND ITS APPLICATIONS:
Linear Differential Equations, Exact Differential Equations, complementary function and particular integral, solution of ordinary linear differential equations of higher order with constant and variable coefficients (Cauchy and Legendre forms); Orthogonal and isogonal trajectories of a family of curves.

Unit –V: PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS:
Introduction to partial differential equations, Lagrange's method of undetermined multipliers for the solution of linear partial differential equations of first order, solution of nonlinear partial differential equations of first order by means of Charpit's methods.

TEXT/REFERENCES BOOKS:

1. Quddus Khan; Advamced Engineering Mathematics, Tyrasons Publications, Delhi-110092, (2022)
2. B. V. Raman, Higher Engineering Mathematics, McGraw Hill Education India, 26th edition 2016.
3. R. K. Jain and S. R. K. Iyengar: Advanced Engineering Mathematicsl Narosa, 5TH Edition, 2018.
4. H. K. Dass; Advanced Engineering Mathematics, S. Chand Publishing, 22nd edition, 2018.

CSS-101: FUNDAMENTAL OF COMPUTING

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	1	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Understand the basics of computer, generation and types of computer and Number system.
CO2	Understand the concept of algorithms, flowchart and C programming basics.
CO3	Implement loops and array in C programming.
CO4	Apply the concepts of searching and sorting techniques in C programming.
CO5	Describe different types of operating systems and its functions and they will understand basics of computer networking and internet.

UNIT-I: BASICS OF COMPUTERS:
Computer fundamentals, Bits and Bytes, CPU, Memory, Types of memory, Input and output devices, Operating system, application software, system software, generation of computer, classification of computer Number system: decimal number system, binary number system, octal number system, hexadecimal number system.

UNIT-II: INTRODUCTION TO C PROGRAMMING:
Introduction to Programming Language, Compiler, Interpreter, Algorithms, flow chart, C character set, C-tokens: constants, variable, keywords, Data types, operator and expressions. Decision controls: if-else, if-else ladder, nested if-else, conditional operator, switch case.

UNIT-III: LOOP AND ARRAY:
For loop, while loop and do-while loop, continue and break statement, Function: inbuilt and user defined functions, call by value and call by reference, Array: Single dimensional array. 2D array, multidimensional array, Operations on array.

UNIT-IV: SEARCHING AND SORTING:
Pointers, searching and sorting, Searching techniques: linear search, binary search, Sorting techniques: bubble sort, selection sort, Strings, library string functions.

UNIT-V: OPERATING SYSTEM & NETWORKING:
OS definition, role of OS in computer system, multi programming, time sharing OS, multitasking OS, multiprocessing OS, real time system OS, client server computing, distributed OS, functions of OS. Computer Network, transmission media, network topologies, LAN, WAN, MAN, Internet, ISP, WWW, Email, URL, Web browsers, websites, intranet. Latest technologies in IT.

TEXT/REFERENCES BOOKS:

1. Herbert Schildt C-The Complete Reference., Tata McGraw Hill Edition
2. Ritchie, D. M., Kernighan, B. W., & Lesk, M. E. (1988). The C programming language. Englewood Cliffs: Prentice Hall.
3. Kamthane, A. N. (2011). Programming in C, 2/e. Pearson Education India.
4. Doja, M. N. (2005). Fundamentals of Computers and Information Technology
5. Yashwant, K. Let us C. 8th edition, BPB publication.
6. Balagurusamy, E. (2012). *Programming in ANSI C*. Tata McGraw-Hill Education.

EES-101: BASICS OF ELECTRICAL ENGINEERING

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	1	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Solve electrical circuits applying KCL, KVL and network theorems.
CO2	Understand the concept of phasors, waveforms and behaviour of basic electric circuit components.
CO3	Analyze the various types of losses in magnetic circuits.
CO4	Understand the construction, operation and applications of DC machines and single phase induction motors.
CO5	Introduce various types of electrical machines and its applications

UNIT-I:
Kirchoff's laws, node voltage and mesh current methods, delta-star and star-delta conversion, classification of network elements, superposition principle, Thevenin's and Norton's theorems.

UNIT-II:
Single phase AC circuits, average and effective values of sinusoids, solution of R,L,C series circuits, the j operator, complex representation of impedances, phasor diagram, power factor, power in complex notation, solution of parallel and series-parallel circuits, resonance. Introduction to balance three phase AC circuits.

UNIT-III:
Introduction to magnetic circuits, analogy between electrical and magnetic circuit, Simple magnetic circuit with DC and AC excitations-Faraday's laws, induced emfs and inductances, magnetic leakages, B-H curve, hysteresis and eddy current loss, magnetic circuit calculations, mutual coupling.

UNIT-IV:
Single Phase Transformers- Principle of operation, construction, e.m.f. equation, ratings, phasor diagram for no-load and full load, equivalent circuit, power losses, regulation and efficiency calculations, open circuit and short circuit tests. Introduction to auto-transformer.

UNIT-V:
Types of electrical machines, working principle and construction of DC and AC machines, domestic and industrial applications of various types of electrical machines.

TEXT BOOKS:
1. V. Del Torro, Electrical Engineering Fundamentals, Second Edition, Prentice Hall of India Pvt. Ltd
2. R. L. Boylestad, Introductory Circuit Analysis, Pearson
3. I. J. Nagrath, Basic Electrical Engineering, McGraw-Hill Education (India) Pvt Limited

REFERENCES BOOKS:
1. S.S. Parker, Problems in Electrical Engineering, Asia Publishing House.
2. H. Cotton, Advanced Electrical Technology, Pitman, London
3. T. L. Floyd, Principles of Electric Circuits, Pearson
4. E. Hughes, Electrical & Electronic Technology, Revised by John Hiley, Keith Brown and Ian Mckenzie Smith, Pearson

ASL-101: LANGUAGE LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	HSMC-L

This laboratory course is designed based on theory course of "Communication Skill" (AST-101). The purpose of this Lab is to develop Communication Skills in the students through Group Discussion, Interviews and Seminars. There are around 8-10 sessions to be conducted by the students covering almost all units of theory course. Apart from Group Discussion, Interviews and Seminars, the other activities conducted in this lab are Self-Introduction, Presentation Skills, Formal Conversation & Chit-Chat, Topic Expressions/ Oration, Word Games, Debates, Simulated discussion, Personality Development, Resume writing, Book Reviews, Affirmative body language/gestures, Voice modulation.

ASL-102: ENGINEERING PHYSICS LAB– I

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	BSC-L

This laboratory course is designed based on theory course of "Physics-I" (ASB-101). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include Physical Pendulum, Moment of Inertia table, Flywheel, Spiral Spring Characteristics, Conversion of Galvanometer into ammeter and voltmeter, Potentiometer, P N Junction Characteristics etc.

ASL-103: ENGINEERING CHEMISTRY LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	BSC-L

This laboratory course is designed based on theory course of "Chemistry-I" (ASB-103). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. For example, determination of (1) the percentage composition of a given mixture of NaCl and NaOH, (2) the surface tension of a given liquid by drop number method using Stalagmometer, (3) strength of a strong acid by drawing titration curve using pH meter, and (4) the strength of a given HCI solution titrating it against N/10 NaOH solution conduct metrically etc.

MEL-104: ENGINEERING GRAPHICS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	BSC-L

This laboratory course is designed to familiarize the students with basics of drawing and design of engineering components. students will be able to understand the detail construction and different view of any object. The course covers various topics such as orthographic projection, isometric projection, sectioning, fasteners building drawings:

ASL-104: DESIGN THINKING & IDEA LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	ESC-L

This course is designed to inculcate design thinking and innovation among the students. The course includes introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry, Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brain storming, product development. Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations, Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity. problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications.

It also includes an exercise in design thinking – implementing design thinking for better process, implement design thinking process in various Industries, Design thinking for Startups, Design thinking in various sectors: Case studies in Information Technology, Finance, Education, Management and Retail sector. Analyze and Prototyping, Usability testing, Organizing and interpreting results.

SECOND SEMESTER COURSES

ASB-201: ENGINEERING PHYSICS – II

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	1	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Learn to apply relativity in describing physics of motion.
CO2	Appreciate the importance of lasers and grasp the physical basis of laser actions.
CO3	Develop a comprehensive understanding of static magnetic fields, their properties and practical applications.
CO4	Apply quantum ideas to explain the behaviour of materials at quantum level.
CO5	Use of semiconducting devices in daily life like mobile, computer etc.

UNIT-I: SPECIAL THEORY OF RELATIVITY:
Inertial and Non-inertial frame of reference, Concept of Ether, Michelson Morley Experiment, Galilean transformations and Galilean invariance, Postulates of special theory of relativity, Lorentz transformations, Einstein velocity addition theorem, Time Dilation, Length contraction, Relativistic mass, momentum and energy.

UNIT-II: LASERS:
Introduction of Laser, General characteristics of lasers, Applications of lasers, Principle of laser action, Concept of Population Inversion, Einstein's transition probabilities, Lifetime of transitions, Rate equation for atomic transition, Rate equations for 3-level laser system, Basic idea of Optical resonators, Working and Principle of Ruby Laser, Argon-ion laser.

UNIT-III: ELECTROMAGNETISM:
Maxwell`s equation: Integral and differential forms of Maxwell equations and their physical significance, Propagation of Electromagnetic waves (EM) in free space: Wave equation in terms of Electric and Magnetic field, Flow of energy, Poynting vector.

UNIT-IV: QUANTUM MECHANICS:
Wave function and its significance, properties of wave function: Normalization, Orthogonal and probabilistic interpretation. Operators (position, momentum and energy), Eigen values and eigen functions, Expectation value of position, momentum and energy. Derivation of Schrodinger time dependent and independent equation for wave function and energy eigen values. One-dimensional problem- confinement of particle in a box.

UNIT-V: PHYSICS OF MATERIALS:
Basic of semiconductors, Concept of doping in semiconductors, Intrinsic and Extrinsic semiconductors, p-type and n-type semiconductors. Effective mass and law of mass action, Carrier concentration, Electrical conductivity and mobility of charge carriers in intrinsic and extrinsic semiconductors, Hall's Effect, Band theory of solids, Origin of energy gap, Kroning Penny Model.

TEXT BOOKS:

1. Concepts of Modern Physics: Arthur Beiser
2. Qunatum Mechanics, Concept and Applications: NouredineZettili.
3. Introduction to Electrodynamics: David J. Griffiths
4. Optics, A. Ghatak
5. Electronic Fundamentals and Applications: J. Milliman and Christos C. Halkias

REFERENCES BOOKS:

1. Principles of Lasers: O. Svelto
2. Fundamentals of Physics: Halliday and Resnick

ASB-202: ENGINEERING MATHEMATICS – II

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	1	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Tracing of 3D curves, evaluation of multiple integrals by change of order of integration, change of variables.
CO2	Series solution and applications of partial differential equations.
CO3	Study of analytical functions, expansion of complex functions, zeros and singularities of functions, theory of residues, evaluation of contour integrals and conformal mappings.
CO4	Laplace transform and is applications in solving differential and integral equations.
CO5	Learning of theory and applications of Fuzzy mathematics.

Unit –I: SOLID GEOMETRY AND APPLICATIONS OF MULTIPLE INTEGRALS:

Formation of equations of cylinder and cone under the given geometrical conditions. Applications of multiple integrals in finding mass, centre of gravity, centre of pressure, moment of inertia, product of inertia, curved surface area and volume.

Unit –II: SERIES SOLUTION AND APPLICATIONS OF P.D.E.:
Ordinary point, regular singular point, series solutions of ordinary differential equations of second order, Frobenius method for the solution of O.D.E.

Unit- III: COMPLEX ANALYSIS AND ITS APPLICATIONS:
Complex function, Analytical function, C-R equations (Cartesian and polar forms), Milne - Thomson method and related problems; Evaluation of complex integrals using Cauchy's integral theorem, Cauchy's integral formula, conformal mapping, Zeros, singularities and residues of an analytic function; Application of Cauchy's residue theorem in solving contour integrals and evaluation of real definite integrals using residue method.

Unit- IV: LAPLACE TRANSFORM AND ITS APPLICATIONS
Notion of Laplace transform and its properties, Laplace transform (some well-known elementary functions and Special functions) , Inverse Laplace transforms and its properties (some well-known elementary functions and Special functions), Laplace transforms of Derivative, Integral, Convolution theorem. Applications of Laplace and inverse Laplace transform in finding the particular solutions of ordinary linear differential equations with constants and variables coefficients, system of differential equations, integral equation, Integro-differential equations.

Unit –V: TENSOR ANALYSIS AND ITS APPLICATIONS:
Notion of tensors, operations on tensors (Addition, subtraction, multiplication and contraction), Types of tensors (reciprocal tensors, Fundamental tensors, Relative tensors, symmetric and skew symmetric tensors), Christoffel symbol and its properties.

Text/ REFERENCES BOOKS

1. Quddus Khan; Advamced Engineering Mathematics, Tyrasons Publications, Delhi-110092, (2022)
2. B. V. Raman, Higher Engineering Mathematics, McGraw Hill Education India, 26th edition 2016.
3. R. K. Jain and S. R. K. Iyengar: Advanced Engineering Mathematicsl Narosa, 5tr Edition, 2018.
4. H. K. Dass; Advanced Engineering Mathematics, S. Chand Publishing, 22"" edition,2018.

ASB-203: BIOLOGY FOR ENGINEERS

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Understand the concept of nanotechnology
CO2	Learn the applications of nanotechnology in multiple disciplines
CO3	Understand the concepts of biological sciences, genetics, biological indicators and biosensors
CO4	Explore the field of advanced biological sciences and biotechnology
CO5	Explore nano-biotechnology and its various applications

UNIT-I: INTRODUCTION TO NANOTECHNOLOGY:
Introduction to Nanotechnology, Theoretical Basis of nanotechnology, Quantum confinement and size effect, Classification of Nanomaterials: Nanowires, QuantumWell and Quantum Dots, Properties of Nanomaterials, Carbonaceous Nanomaterials and their examples. Molecular Nanotechnology, Green Nanotechnology.

UNIT-II: FUNDAMENTALS OF AI, DATA SCIENCE, AND MACHINE LEARNING:
AI Introduction, Applications in Engineering, Types & Subfields, EthicalConsiderations. Data Science Overview, Significance in Engineering, Components, Data Types, Tools & Languages. Python Fundamentals: Variables, Data Types, Control Structures. Machine Learning Introduction, Types, Workflow, Popular Algorithms, Python for ML. Practical AI Applications in Engineering: Automation, Maintenance, Computer Vision, NLP, Optimization. Case Studies.

UNIT-III: INTRODUCTION TO BIOLOGICAL SCIENCES:
Darwinian evolution & molecular perspective; Introduction to phylogeny -Classification systems in biology and relationships; Cellular assemblies – From single cell to multi – cellular organisms: Geometry, Structure and Energetics; Comparing natural Vs human-made machines, Chromosomes and Cell Division. Basic Genetics-biological indicators, Mutation-causes. types and effect.

UNIT-IV: BASICS OF MICROBIOLOGY & IMMUNOLOGY:
Introduction to microbiology, Introduction to immunology, Immunology – A classic example of permutations and combinations in biology; Concept of Gene, Gene regulation, Infection, disease and evolution – synergy and antagonism; Cancer biology – Control and regulation; Stem cells – Degeneracy in biological systems; Engineering designs inspired by biology – Micro – to Macro – scales.

UNIT-V: BIOTECHNOLOGY:
Basic concepts of biotechnology: Totipotency and cell manipulation, Classifications of biotechnologies, Bio-Processing Technologies, Imaging techniques, Electrophysiology, Introduction to Nanobiotechnology, Regenerative medicine, Targeted drug delivery. Nanoimaging, Cancer treatment using Nanotechnology, Nanotoxicology: basics of cellular and organ level toxicity.

TEXT/REFERENCES BOOKS:

1. B. S. Murthy, P. Shankar, B. Raj , J. Murday, " Text Book of Nanoscience& Nanotechnology", Universities Press Springer.
2. Tom Taulli, "Artificial Intelligence Basics: A Non-technical Introduction", Apress.
3. Mark Lutz "Learning Python", OReilly Media publishers, 5th Edition.

ECS-201: BASICS OF ELECTRONICS & COMMUNICATION ENGINEERING

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Familiarize with the semiconductor diodes and various logic gates
CO2	Analyze biasing, load line and amplifier action of transistor
CO3	Design various operational amplifier circuits
CO4	Explain oscillators, CRO and electronics multi-meters
CO5	Familiarize with various schemes of modulation

UNIT I : SEMICONDUCTOR DIODES:
P-N Junction diode, V-I characteristics, static and dynamic resistance, linear and non-linear applications of diodes, half wave, full wave and bridge rectifiers, Zener diode, characteristics and its use as a voltage regulator. AND, OR, NAND, NOR and Ex-OR gates.

UNIT II : TRANSISTORS (BJT & JFET):
Bipolar junction transistor (BJT), biasing and amplifier action, load line analysis of transistor amplifier, BJT amplifier configurations, Junction field effect transistor (FET), biasing and amplifier action.

UNIT III : OPERATIONAL AMPLIFIER:
Op-amp basics, practical op-amp circuits, inverting and non-inverting amplifier, summing amplifier, integrators and differentiators.

UNIT IV : FEEDBACK AND ELECTRONIC INSTRUMENTS:
Feedback concept, Barkhausen Criteria of oscillation, Wein bridge and phase shift oscillator, cathode ray oscilloscope (CRO), electronics multi meters.

UNIT V : COMMUNICATION SYSTEMS:
Introduction to modulation, amplitude modulation, generation of AM waves, demodulation of AM waves, introduction to FM.

TEXT BOOKS:

1. J. Millman and A. Grabel, 'Microelectronics' 2nd Edition, McGraw Hill, International Edition, 1988.
2. Robert boylestad and Louis Nashlesky, 'Electronic Devices and Circuit Theory' 5th Edition, PHI, 1992.

REFERENCE BOOKS:

1. Schilling and Beloved, 'Electronic Circuits-Discrete and Integrated', McGraw Hill International Edition, 1988.
2. Simon Haykin, 'Communication Systems', 2nd Edition, Wiley Eastern Ltd, New Delhi, 1992

MES-201: BASICS OF MECHANICAL ENGINEERING

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	ESC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Apply the basic laws of thermodynamics in engineering system for analysis.
CO2	Understand the concepts of Fluid Mechanics and recognize the various types of problem when the fluid is at rest or in motion.
CO3	Analyze the real time applications of heat transfer and describe the fundamental modes of heat transfer.
CO4	Apply the principle of impulse and momentum to solve three-dimensional rigid body kinetics problems including gyroscopic motion.
CO5	Determine the inversions of kinematic chain and degrees of freedom of a mechanism.

UNIT-I: THERMODYNAMICS:
Introduction to Thermodynamics, Concepts of systems, control volume, state, properties, Equilibrium, quasi-static process, reversible & irreversible process, cyclic process. Zeroth Law and Temperature Heat and Work, First Law of Thermodynamics for closed & open systems. Non-Flow Processes, numerical based on the above concepts Energy Equation. Steady Flow Energy Equation. Numerical based on SFEE. Second Law of Thermodynamics-Kelvin and Plank's and Clausius Statement.

UNIT-II: FLUID MECHANICS:
Introduction, fluid properties, basic equation of fluid statics pressure variation in a static fluid, hydro-static force on submerged surfaces buoyancy and stability fluids in rigid-body motion Introduction to fluid dynamics

UNIT-III: HEAT TRANSFER:
Heat Transfer: What and how?
Application areas of heat transfer, historical background, Physical origin and heat transfer mechanism/Modes of heat transfer: Conduction, Convection and Radiation, Fourier's law of heat conduction, Thermal conductivity of materials
Thermal resistance, General heat conduction equation, Newton's law of cooling, Surface emission properties: absorptivity, reflectivity and transmissivity, Concept of a black body, The Stefan-Boltzmann law and Kirchhoff 's law, problems

UNIT-IV: DYNAMICS OF RIGID BODIES:
Angular momentum of a rigid body in three dimensions, Application of the principle of impulse and momentum to the three-dimensional motion of a rigid body, Kinetic energy of a rigid body in three dimensions, Motion of a rigid body in three dimensions, Euler's equations of motion, Motion of a rigid body about a fixed point, Rotation of a rigid body about a fixed axis, Motion of a gyroscope. Eulerian angles, Steady precession of a gyroscope

UNIT-V: BASIC CONCEPT OF MECHANISMS AND MACHINES:
Link, kinematic pairs and their classifications, Kinematic chain, Mechanism and their inversions. Degree of Freedom of a mechanism, Four bar chain and its inversions, Single and double Slider-crank chains, Quick return motion mechanisms, Mobility of four bar linkage (Grashof criterion), Power Transmission systems: Gear Drives, belt drives, chain drives, friction drives

TEXT BOOKS:

1. Engineering Thermodynamics, P. K. Nag, Tata McGraw-Hill 2005
2. Vijay Gupta & Santosh K Gupta, Fluid Mechanics and ItsApplications, Third Edition, New Age International, 2017
3. Sachdeva, R.C., Fundamentals of Heat and Mass Transfer, 4th ed.,New Age International, 2012
4. Ferdinand P. Beer, E. Russell Johnston, Jr., David F. Mazurek, Phillip J. Cornwell, Brian P. Self, Vector Mechanics For Engineers: Statics And Dynamics, Twelfth Edition, McGraw Hill Education.
5. Ghosh & Mallick, Theory of Mechanisms and Machines, EWP

REFERENCES BOOKS:

1. Fundamentals of Classical Thermodynamics, G. J. Van Wylen and R. E. Santag
2. Fox & McDonald, Introduction to Fluid Mechanics, Fifth Edition, John Wiley & Sons, Inc. 2004

CES-201: BASICS OF CIVIL ENGINEERING

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	ESC	45

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Understand various disciplines of civil engineering and different types of structures.
CO2	Understand various systems of Infrastructure.
CO3	Recognize different materials and equipment used in Civil Engineering.
CO4	Understand different components of buildings.
CO5	Explain various material properties and calculate uniaxial deformations.

Unit-I: Overview - Introduction to Civil Engineering; Broad Civil Engg. Disciplines; Different Civil Engineering structures (Only Types): Buildings, Bridges, Aqueducts and viaducts, Towers and Chimneys, Tunnels, Dams, Retaining Walls, Tanks, Coastal defences.

Unit-II: – Roadways, Railways, Airports, Distance and Elevation Measurements, Water Supply Systems, Sewage Systems, Solid Waste Management Systems, Power Supply Systems, Emergency Systems.

Unit-III: Civil Engineering Materials and Equipments - Materials: Cement, Steel, Stone, Bricks, Timber, Mortar, Concrete; Equipments: Excavator, Bulldozer, Road Rollers, Concrete Mixer, Needle Vibrator, Non-destructive Testing Equipment.

Unit-IV: Building components & Services - Types of Foundations: Isolated, Combined, Strap, Mat/ Raft, Piles, Well, Piled-Raft; Super-structure: Plinth, Floor, Wall, Column, Beam, Slab, Ceiling, Cantilever, Stairs; Lifts, Sanitary and Plumbing appurtenances.

Unit-V: Material Properties and Uniaxial Deformation - Uniaxial Tension Test: Stress-Strain Diagrams for Different Materials, Elasticity, Yielding, Plasticity, Work Hardening; Normal Stress & Strain, shear Stress & Strain, Stress-Strain Relationship; Elastic Constants and their inter-relationships, Uniaxial Deformations in uniform x-sections.

TEXT/ REFERENCES BOOKS:

1. Basic Civil Engineering by Satheesh Gopi, Pearson
2. Basic Civil Engineering by Punmia, Jain & Jain, Laxmi Publication
3. Basic Civil Engineering by S. S. Bhavikatti, New Age International Publishers
4. Building Materials by S. K. Duggal, New Age Press
5. Mechanics of Solid by Abdul Mubeen, Pearson, Pearson Education
6. Infrastructure Engineering and Construction Techniques by Lad, Kulkarni, Patil, Minde, Apte, Phadke, Nirali Prakashan

ASM-201: CONSTITUTION OF INDIA

L	T	P	Credit	Assessment:	Type of Course	Total No. of Teaching Hours
2	0	0	0	Mid Sem.40%+ End Sem.60% =100%	MC-I (Audit)	30

COURSE OUTCOMES: After the completion of the course, the students will be able to

CO1	Understand the history and structure of the Indian Constitution and its important parts.
CO2	Understand the features and preamble of constitution of India.
CO3	Develop an awareness of the fundamental rights and duties as a responsible citizen of India.
CO4	Explore how different parts of the government like the President, the Prime Minister, Parliament, State Governments and Judiciary work together to govern the country.
CO5	Develop the knowledge of elections and activities of Elections Commission of India.

Unit-I: Introduction
Constitution of India: Sources, interpretation and constitutional history, salient features of the constitution

Unit-II: FEATURES AND PREAMBLE OF THE CONSTITUTION OF INDIA
The Preamble of the constitution, socialism, secularism, democracy, republican charter, justice, liberty, equality, fraternity, dignity of the individual, unity and integrity of the nation.

Unit-III: CITIZENSHIP AND THE FUNDAMENTAL RIGHTS OF THE CITIZENS OF INDIA.
Citizenship, fundamental rights of a citizen: right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and educational rights, right to constitutional remedies, fundamental duties of a citizen.

Unit-IV: THE UNION AND STATE LEGISLATURES AND THE JUDICIARY
The union executives: The President, The Vice President, Council of Ministers, The Prime Minister, Attorney General of India. The Union Legislature: the Parliament and Parliamentary proceedings. The Judiciary - The Supreme Court, The High Court and the sub ordinate courts: its powers and functions. The states and union territories, Union-State relations.

Unit-V: ELECTIONS, FUNCTIONS AND ROLE OF ELECTION COMMISSION.
Elections: electoral reforms. The Election Commission – role of chief election commissioner, power and functions of the Election Commission of India. Amendment of the Constitution. Panchayti Raj. Working of the Constitution.

TEXT BOOKS:
1. Subhash C Kashyap, Our Constitution, National Book Trust, India 2012

REFERENCES BOOKS:
1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd. New Delhi 2014
2. J.A. Siwach, Dynamics of Indian Government & Politics, 2nd Edition 2016

ASL-201: ENGINEERING PHYSICS LAB-II

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	BSC-L

This laboratory course is designed based on theory course of -Physics-11" (ASB-201). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course They include Laser experiments, Melde's Experiment, Newton's rings, Spectrometer, Conductivity Study, Hall Effect, Photo Diode Characteristics, Planck Constant determination, Zener Diode Characteristics, Damped Harmonics motion.

MEL-201: WORKSHOP PRACTICE LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	ESC-L

This laboratory course is designed to enable the students to understand science and engineering of every task and tool employed in each shop/trade, to instill fundamentals of materials, properties, various tools and their specifications employed in various shops/trades and to understand the drawing and specification of various tasks/jobs; plan, operate and acquire tools to make jobs as per specifications. This course includes experiment of fitting shop, pattern making shop, foundry shop, welding shop, lathe machine (machine shop),etc.

MEL-202: ENGINEERING MECHANICS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	ESC-L

This laboratory course is designed to familiarize the students with Engineering mechanics practically. There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include determination of co-efficient of friction between various surfaces on an Horizontal plane apparatus, inclined plane apparatus, mechanical advantage, Velocity ratio and efficiency of the Differential wheel and Axle apparatus, beam reactions in Simply supported beams for different loads using parallel beam apparatus etc.

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THIRD SEMESTER COURSES

EEC-301: ELECTRONICS DEVICES AND CIRCUITS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Group discussion etc.

Pre requisites: Should know basic circuit analysis

COURSE OBJECTIVES & COURSE DESCRIPTION: The course aims to equip students with a comprehensive knowledge of electronic devices and circuits used in modern electronics. The syllabus encompasses the fundamental properties and equations of JFETs and MOSFETs, amplification techniques, operational amplifier basics, amplifier types, power amplifiers, feedback mechanisms, and oscillator circuits. Students will gain practical insights into designing and analyzing electronic circuits, making them well-prepared for careers in electronics engineering, circuit design, and related fields. This course forms the foundation for understanding and working with electronic devices and circuits in a wide range of applications.

COURSE OUTCOMES: After successfully completing the course, students should able to:

CO1	Possess a strong understanding of JFET and MOSFET with applications.
CO2	Possess skills in analyzing and understanding Operational Amplifier (Op-Amp), and its fundamentals.
CO3	Excel in development of circuits for Op Amp based applications.
CO4	Learn various power amplifier classes (class-A, class-B, class-C, and class-D) and evaluating their distortion and efficiency characteristics.
CO5	Understand the concept of feedback with different configurations and also able to apply concept for practical applications.

UNIT-I: Fundamentals of Diodes, JFET: Common Source, Common Gate configurations and Source follower. MOSFET: Depletion type MOSFETs and Enhancement type MOSFETs. VMOS and CMOS. Biasing and small signal AC analysis of FETs.

UNIT-II: Darlington pair, Emitter follower, Current mirror, Differential amplifier (Emitter-coupled), CMRR. Amplifier fundamentals, Op-amp basics and its equivalent circuit, Input offset voltage and current, Input bias current, Gain bandwidth.

UNIT III: OP-AMP based circuits:Non-inverting, Buffer, Inverting, Summing, Differentiating, Integrating amplifier, Logarithmic, Anti-logarithmic, Instrumentation amplifier. Schmitt trigger circuit, Precision rectifier, Peak detector, and Active filter.

UNIT-IV: Power Amplifier: Introduction and definition. Series fed class-A amplifier, Transformer coupled class-A amplifier, Class-B, Class-C, and class-D power amplifier. Push-Pull amplifier circuit. Distortion and efficiency of Power Amplifier.

UNIT-V: Feedback concept and types of feedback, Feedback connections. Effect of negative feedback on amplifier's input impedance, output impedance, gain, stability and bandwidth. Barkhausen's criterion for oscillation, Phase-shift oscillator, Wien's bridge oscillator, 555 timer, Voltage controlled oscillator.

TEXTBOOKS:

[T1] Robert Boylested, Louis Nashelky, "Electronic Devices and Circuit Theory", Pearson Education, New Delhi, India,11th edition, 2015

[T2] Jacob Millman, Christor C. Halkias, "Electronic Devices and Circuits", McGraw Hill Book Company, New Delhi, India,4th edition, 2015

REFERENCE BOOKS:

[R1] Adel Sedra, Kenneth C. Smith, Tony Chan Carusone, Vincent Gaudet, Microelectronic Circuits (The Oxford Series in Electrical and Computer Engineering, 8th edition, 2020

[R2] Sergio Franco, Design with Operational Amplifier and Analog Integrated Circuits, McGraw Hill Book Company, New Delhi, India, 3rd edition, 2017.

[R3] E. Norman lurch, "Fundamental of Electronics", John Wiley and Sons, New York, USA, 3rd edition, 1981.

[R4] Donald L. Schilling, Charles Belove, "Electronic Circuits: Discrete and Integrated," McGraw Hill Book Company, New Delhi, India,3rd edition, 1989.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Analog Electronic Circuit	Prof. Shouribrata Chatterjee	IIT Delhi

Computer Usage / Software required: LTSpice

EEC-302: NETWORK ANALYSIS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Basic understanding of electrical components and their circuits with applicable laws/theorems.

COURSE OBJECTIVES & COURSE DESCRIPTION: This course is intended to inculcate among students the ability to represent and analyze the given electrical circuits. Representation through the graph theory concepts and mathematical tools. Analysis to study the steady state as well as transient response and finally the stability of the circuit response to given input.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Represent the given circuit by suitable graph and vice versa. Write minimal set of equations for the analysis of circuits.
CO2	Obtain steady-state and transient response of electrical circuits.
CO3	Perform analysis of two-port networks through various parameters.
CO4	Perform time domain and frequency domain circuit analysis.
CO5	Perform simple electrical circuits synthesis

UNIT-I: Network graph, properties of tree in a graph, incidence matrix, cut- set matrix, tie- set matrix and their properties, No. of possible trees of graph, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Reciprocity theorem, duality.

UNIT-II: Transfer function, transient and steady state system, transient response, natural response, zero state response, initial condition, complete response: inductance, capacitance, RL, RC and RLC network their Continuity relationship, their response to sinusoidal input, to exponential excitation, second order response.

UNIT-III: Two port networks, synthesis, impedance parameters, admittance parameters, transmission parameters, inverse transmission parameters, hybrid parameters, inverse hybrid parameters, their reciprocity and symmetry conditions, inter- relationship between the parameters, interconnection of two port networks, cascaded connection, series, parallel, series –parallel connection.

UNIT-IV: Network functions, driving point impedance function, voltage transfer function, ladder network, poles-zeros, necessary condition for transfer function, necessary conditions for driving function, effect of pole position on stability, significance of pole zero position, timedomain and frequency response from pole- zero plot.

UNIT-V: Driving point immitance function: properties, physical realizability, Synthesis: Hurwitz polynomial and properties, positive real function and properties, LC, RC, RL- network and their synthesis using Foster –I, II and Cauer –I, II form.

TEXT/REFERENCE BOOKS.

1. Networks and Systems by D. Roy Chaudhary, New Age International Publishers
2. Network Analysis by Mac E. Van Valkenberg, Pearson India Education Services Pvt. Ltd., 3rd Edition, 2019.
3. Engineering Circuit Analysis by William H. Hayt Jr., Sixth Edition- 2006,
4. Network analysis and synthesis by F. F. Kuo
5. Network analysis and synthesis by C. L. Wadhwa
6. Fundamentals of Network analysis and synthesis by Behrouz Peikari

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Network Analysis	Prof. Tapas Kumar Bhattacharya	IIT Kharagpur

EEC-303: SIGNALS AND SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Mathematics-I, and Engineering Physics

COURSE OBJECTIVES & COURSE DESCRIPTION: To understand the fundamental characteristics of signals and system. To understand signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provides. To develop the mathematical skills to solve problems involving convolution, filtering, and sampling.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Demonstrate knowledge of basic sciences to understand behavior of various signals.
CO2	Identify, formulate and solve engineering problems by Fourier Techniques.
CO3	Represent systems by mathematical equations.
CO4	Demonstrate the ability to analyze signals by Laplace Technique.
CO5	Show the ability to apply techniques to solve problems by Z-transform Techniques.

UNIT-I: Morphology of signals and their classifications, even and odd functions, orthogonal function. Step, impulse, ramp and other non-sinusoidal signals and wave forms as the sum of electrical functions. Fourier series representation. Use MATLAB for signal generation.

UNIT-II: Amplitude and frequency spectra. Fourier integral and Fourier transform and their properties. Convolution and Parseval's theorems. System representation using differential equations and transfer function. Use MATLAB for signal convolution.

UNIT III: Impulse response. Poles and zeros of a system. Analysis of linear time invariant (LTI) systems using Laplace transform Frequency response of LTI systems, zero input response, forced input response. Stability of LTI systems, pole-zero criteria for stability. Use MATLAB for calculating ZIR (zero input response), FIR(Forced Input Response), stability criteria.

UNIT-IV: Introduction to Z-transform, inverse Z-transform, region of convergence. Poles and zeros. Difference equation, transfer function, impulse response. examples. Application of Z-transform for the analysis of discrete-time LTI systems with examples. Use MATLAB for signal generation.

UNIT-V: Correlation: Energy signals, power signals, autocorrelation, cross-correlations its properties and examples. Power spectral density, its definition and derivations. Use MATLAB for signal generation its usage

TEXTBOOKS:

[T1] S. Hykin and B. V. Veen, "Signals and Systems", John Wiley, 2000
[T2] Hwei P. Hsu "Schaum's Outlines of Signals and Systems" McGRAW-Hill, second edition, 2011.

REFERENCE BOOKS:

[R1] Sanjay Singh, "Signals & Systems" S. K. Kateria & Sons, 2011.
[R2] Steven T. Karris "Signals and Systems with MATLAB Computing and Simulink Modeling" Fourth Edition, Orchard Publications, April 2008, www.orchardpublications.com
[R3] Mahmood Nahvi, "Signals and Systems", McGraw Hills Indian Edition, 2015.
[R4] Manaullah Abid Husain,"MATLAB AND SIMULINK", CAD Plan Publisher and Distributer, Delhi-25, 2012
[R5] Manaullah Abid Husain, "Programming with Python & MatLab , CAD Plan Publisher and Distributer, Delhi-25, 2024.

WEB RESOURCE: https://archive.nptel.ac.in/course/108/105/108105064/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Signals & Systems	Prof. V.M. Gadre	IIT Bombay

Computer Usage / Software required: Matlab

EEC-304: TRANSFORMER AND INDUCTION MACHINE

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Basics of Electrical Engineering

COURSE OBJECTIVES & COURSE DESCRIPTION: The objective of this course is to have the knowledge of construction, principle of operation, classifications and applications of transformer and induction machine. In this course Analysis of various parameters is done which affects the performance of transformers and induction machines.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Understand the basic fundamentals & functioning of transformer
CO2	Analyze the losses, efficiency of transformer and performing various tests on transformers
CO3	Illustrate the principle working and comparison of autotransformer with two-winding transformer and construction of 3-phase induction motor
CO4	Understand the fundamentals, classification and operations of 3-phase induction motor
CO5	Illustrate the tests performed on 3-phase induction motor and performance characteristics of 1-phase induction motor.

UNIT-I:TRANSFORMER: General constructional features of transformers, types of transformers, e.m.f. equation, working principle. Voltage, current and impedance relationships. Phasor diagram on no-load and full-load. Exact and approximate equivalent circuits. Open circuit and short circuit tests.
Per-unit representation. Voltage regulation, conditions for maximum regulation, zero regulation and minimum regulation. Significance of voltage regulation in power and distribution transformers.

UNIT-II: TRANSFORMER: Losses and efficiency, condition for maximum efficiency. Efficiency consideration in power and distribution transformers. All-day efficiency. Phasing out in three-phase transformer units. Polarity test. Single-phase transformers connected as three-phase bank. Comparison of 3-phase unit with 3-phase bank. Star/star, delta/delta, star/delta, delta/star and open delta connections. 3-phase to 2-phase and 3-phase to 6-phase conversions. Need and conditions for parallel operation, load sharing with equal and unequal voltage ratios, effect of per-unit impedance and X/R ratio, proportional load sharing.

UNIT III: TRANSFORMER: Principle of working and comparison of autotransformer with two-winding transformer. Advantages of tertiary winding in a three-winding transformer. Harmonics and magnetizing inrush in transformer. Transformer applications feeding special loads, transformer performance and testing using simulation tools
3-PHASE INDUCTION MOTOR: General constructional features. Qualitative description of working of 3-phase induction motor from rotating field viewpoint. Stator fed and rotor fed induction motor. Steady state analysis: Equivalent circuit, phasor diagram, power flow diagram. Steinmetz IEEE equivalent circuit.

UNIT-IV: 3-PHASE INDUCTION MOTOR: Thevenin's equivalent model, torque-speed equation and characteristic, motoring, generating and braking regions, starting torque, maximum torque. Concept of leakage reactance and its importance in machine performance and design. Effect of rotor resistance on performance of induction motor. Deep-bar rotor and double-cage rotor. Starting, speed control and braking.

UNIT-V: 3-PHASE INDUCTION MOTOR: No-load and blocked-rotor tests, circle diagram, prediction of Performance by circle diagram. Effect of space harmonics and time harmonics, crawling and cogging.
Open, semi-closed, closed slots and their effect on motor performance.
SINGLE PHASE INDUCTION MOTOR: Double revolving field theory, principle of operation based on double revolving field theory, forward torque and backward torque, torque-speed characteristic. Equivalent circuit based on double revolving theory. Starting methods: Resistance-start split-phase, capacitor-start, capacitor-run, 2-value capacitor type motors, shaded pole motor, characteristics and applications.

TEXT/REFERENCE BOOKS:

[T1] . I.J. Nagrath and D.P. Kothari, "Electrical Machines", Tata McGraw Hill, New Delhi.

REFERENCE BOOKS:

[R1] Ashfaq Husain, "Electric Machines", Dhanpat Rai & Co.
[R2] George McPherson, "An Introduction to Electric Machine and Transformers", John Wiley, NewYork.
[R3] A.E. Fitzgerald, C. Kingsley and S.D. Umans, "Electric Machinery", Tata McGraw Hill, New Delhi.

WEB RESOURCE:

[W1] https://archive.nptel.ac.in/courses/108/102/108102146/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Electrical Machines	Prof. G. Bhuvaneshawri	IIT Delhi
2.	Electrical Machines-I	Prof. G. Sridhara Rao	IIT Madras

ASB-301: ENGINEERING MATHEMATICS-III

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	BSC	45

Course Outcomes:

CO1	To demonstrate the application of Gauss divergence, Stoke, and Green theorems
CO2	To understand the concept of probability and statistics
CO3	Applications of Fourier transforms to Integral equations
CO4	Application of Z-transforms to the difference equations
CO5	To diagnose the nature of the series.

UNIT –I: VECTOR CALCULUS AND ITS APPLICATIONS:
Scalar and vector function, gradient of a scalar field, divergence of a vector field, Curl, Gauss divergence theorem, Green's Theorem, Stoke's Theorem and related problems based on them

UNIT –II: LINEAR ALGEBRA AND ITS APPLICATIONS:
Consistency of a system of simultaneous linear equations using rark, Eigen values and Eigen vectors of a square matrix, Cayley-Hamilton theorem and its applications, vector space, basis, linear dependence and independence of vectors, Linear transformations and related problems based on them.

UNIT - III: FOURIER SERIES, FOURIER TRANSFORMS AND ITS APPLICATIONS:
Fourier's series (full range and half range) for arbitrary period, Representations of a function in terms of Fourier integral, Fourier Sine integral and Fourier Cosine integral, Inverse Fourier transforms, Application of Fourier transform

UNIT - IV: DIFFERENCE EQUATIONS, Z-TRANSFORMS AND ITS APPLICATIONS
Difference Equations, Formation of Difference equations, order of Differenece equations, Linear Difference equations and its solutions, Z-Transforms and its properties, Z-Transforms of some elementary functions, inverse Z-transforms, Convolution theorem for Z-Transform, Application of Z-Transform in solving difference equations

UNIT –V: PROBABILITY AND STATISTICS:
Probability theorems, Probability distribution (Binomial distribution, Poisson and Normal distributions), Moment, Skewness, Kurtosis, Rank of correlation

TEXT/ REFERENCE BOOKS

1. Quddus Khan; Advamced Engineering Mathematics, Tyrasons Publications, Delhi-110092, (2022)
2. B. V. Raman, Higher Engineering Mathematics, McGraw Hill Education India, 26th edition 2016.
3. R. K. Jain and S. R. K. Iyengar: Advanced Engineering Mathematicsl Narosa, 5tr Edition, 2018.
4. H. K. Dass; Advanced Engineering Mathematics, S. Chand Publishing, 22"" edition,2018.

ASM-301: UNIVERSAL HUMAN VALUES (UHV) : UNDERSTANDING HAROMONY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	MC	45

Course Outcome:

CO1	Understanding basic concept of universal human value and basic human aspirations.
CO2	Understanding harmony in self and its importance learning concept of happiness.
CO3	Knowing about harmony in family and society, the value of relationship, respect, trust.
CO4	Learning about harmony and disharmony with nature and its fulfillment.
CO5	Learning importance of understanding harmony and its impact on professional ethics.

UNIT I – Introduction, Concept of Universal Human Value (UHV)
Introduction, need, characteristics of UHV, difference between value-based education and skill based education, benefits of value education, Basic Human Aspirations – Meaning and basic requirements for fulfilling. Measures to fulfil the basic human aspirations in the current scenario. Continuous happiness and prosperity, understanding happiness and prosperity correctly, understanding of relationships.

UNIT II- Understanding Harmony in self
Concept of Human Existence – Conscious and Material Entities, Difference between the Conscious and the Material Entities of Human Existence, Measures to ensure Harmony in the Self. Need of self and the body – happiness and physical facility. Body as an instrument – the doer, seer and enjoyer.

UNIT III – Understanding Harmony in Family and Society
Exploring value of feelings in relationships, Measures to ensure Harmony in the family. Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation: Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order; Understanding conflict (meaning, types), Dimensions of Human order for harmony in society, Universal value of justice, democracy, respect and gratitude. Values Crisis in contemporary society, Nature of values: Value Spectrum of a good life, Psychological values: Integrated personality; mental health, Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.

UNIT IV – Understanding Harmony in Nature and Existence
Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature. Meaning of harmony in nature. Disharmony with Nature – causes. Implications of disharmony with nature. Harmony through symbiotic relationship with nature, Achieving competence in maintaining harmony with nature in professional life.

UNIT V – Implications of Understanding Harmony on Professional Ethics
Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of the Technologists. Codes of professional ethics. Whistle blowing and beyond, ethics of duty, ethics of responsibility. Holistic Technologies, Production Systems and Management Models; Strategies for Transition towards Value-based Life and Profession

TEXT BOOKS/ REFERENCE BOOKS:

1. Simon Blackburn Being Good: A Short Introduction to Ethics, Oxford University Press, 2001.
2. Peter Singer, The Most Good You Can Do: How Effective Altruism Is Changing Ideas About Living Ethically, Yale University Press 2015.
3. Govindarajan M Professional Ethics and Human Values 2013.
4. R.S. Naagarazan, A Textbook on Professional Ethics and Human Values, New Age International, 2007.

AST-401: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2	0	0	0	Mid Sem.40%+ End Sem.60% =100%	MC	30

COURSE OUTCOME: After successfully completing the course, students should be able to

CO1	Understand the importance of traditional knowledge
CO2	Understand the need of protection of traditional knowledge
CO3	Understand the legal framework for Traditional Knowledge
CO4	Understand intellectual property mechanisms for traditional knowledge
CO5	Understand traditional knowledge in different sectors

UNIT – I: Introduction to traditional knowledge
Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge.

UNIT- II: Protection of traditional knowledge
The need for protecting traditional knowledge Significance of TK Protection, the value of TK in the global economy, Role of Government to harness TK.

UNIT - III: Legal framework and Traditional Knowledge
A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);
B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

UNIT- IV: Traditional knowledge and intellectual property
Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT-5: Traditional knowledge in different sectors
Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

TEXTBOOKS:

[T1] Traditional Knowledge System in India, by Amit Jha, 2009.
[T2] Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.

REFERENCE BOOKS:

[R1] Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
[R2] Knowledge Traditions and Practices of India, Kapil Kapoor, Michel Danino

WEB RESOURCE :

[W1] http://nptel.ac.in/courses/121106003/

EEL-301: ELECTRONICS DEVICES AND CIRCUITS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of - Electronics Devices and Circuits (EEC-301). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. This laboratory is equipped with high quality dual channel oscilloscopes (C.R.O.), dual power supply, function generators, digital multimeters, milliammeters and micro-ammeters and a voltmeters and ammeters. Here the students are trained to identify the basic electronic devices like transistor, diode and digital ICs and their pin-configuration. The students are encouraged to lookup the analog and digital circuits on bread board and test them using various testing equipments.

EEL-302: NETWORK ANALYSIS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Network Analysis" (EEC-302). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course The experiments include verification of Reciprocity theorem, Maximum power transfer theorem, Tellegan,s theorem, Z, Y, A, B, C, D, and h-parameters of two port networks, transient response of R, L, C network etc.

EEL-303: SIGNALS AND SYSTEMS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Signals and Systems" (EEC-303). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course The experiments are simulation based performed in MATLAB. The experiments include verification of Reciprocity theorem, Maximum power transfer theorem, Tellegan,s theorem, Z, Y, A, B, C, D, and h-parameters of two port networks, transient response of R, L, C network etc.

EEL-304: TRANSFORMERS AND INDUCTION MACHINE LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Transformers and Induction Machine" (EEC-304). There are around 7-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include open and short circuit tests of single phase transformer, parallel operation of three phase transformer, efficiency curve of a single phase transformer, no-load and blocked rotor test of a three phase induction motor etc.

FOURTH SEMESTER COURSES

EEC-401: DC AND SYNCHRONOUS MACHINES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Fundamentals of Electrical Engineering

COURSE OBJECTIVES & COURSE DESCRIPTION: This subject course objective is to introduce students about the core concepts, explanation of different phenomenon and governing equations related to DC Machines and Synchronous Machines. This course along with Transformers and Induction motors develops a comprehensive understanding of static and dynamic electrical machines.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand and demonstrate the knowledge about constructional aspects of DC machines i.e. DC Motors and DC Generators.
CO2	Identify and describe the fundamental concepts related to principles of operation of DC machines
CO3	Apply, formulate, and solve numerical problems related to performance and design of DC machines and synchronous machines.
CO4	Explore and evaluate the available techniques, skills and design tools related to Synchronous machines i.e. Synchronous Motors and Synchronous Generators.
CO5	Evaluate and suggest types of DC machines and synchronous machines for field application.

UNIT-I: DC Machine: General constructional features of DC Machines, Equivalent Circuit of DC Machines; EMF equation of DC Machines, Armature winding: lap winding, wave winding. Armature Reaction: Armature flux distribution and its effects, brush shift, demagnetizing and cross magnetizing m.m.f., commutation, interpoles and compensating winding.

UNIT-II: DC Generator: Types and governing equations, Voltage buildup in DC Generators, Characteristics of DC Generators: Magnetization characteristics, External and internal characteristics of separately excited and self excited DC generators. Applications of DC Generators. Parallel operation of DC generators.

UNIT III: DC Motor: Types and governing equations, Load characteristics of separately excited, shunt, series and compound motors. Starting, speed control and braking of DC Motors. Testing- Swinburne'stest; separation of losses.Power balance, losses and efficiency, condition for maximum power output and maximum efficiency. Applications of DC Motors. DC Machine testing using simulation and interface tools.

UNIT-IV: General constructional features of Synchronous Machines. Salient-pole machine: Two reaction theory, principle of operation, e.m.f. equation, Cylindrical rotor machine- interaction between excitation flux and armature m.m.f., steady state equivalent circuit and phasor diagram, Steady state power flow and power angle characteristics. Open- circuit, short-circuit and zero power factor (lagging) tests. Short Circuit Ratio (SCR). Voltage regulation of alternator and its determination.

UNIT-V: Synchronous Generator: Synchronization and parallel operation of synchronous generators (Alternators). Governor characteristics and load sharing. Synchronizing current, synchronizing power and synchronizing torque. Synchronous Motor: Starting methods of synchronous motor. Operation as synchronous condenser. Effect of variation in excitation at constant load, V-curves, inverted V-curves. Power angle equations and characteristics. Determination of Xd and Xq by slip test. Synchronous machine testing using simulation and interface tools.

TEXTBOOKS:

[T1] I.J. Nagrath and D.P. Kothari, "Electrical Machines", Tata McGraw Hill, New Delhi.
[T2] Ashfaq Husain, "Electric Machines", Dhanpat Rai & Co.

REFERENCE BOOKS:

[R1] George McPherson, "An Introduction to Electric Machine and Transformers", John Wiley, New York.
[R2] A.E. Fitzgerald, C. Kingsley and S.D. Umans, "Electric Machinery", Tata McGraw Hill, New Delhi

WEB RESOURCE :

[W1] http://nptel.ac.in/courses/electricalmachines

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Electrical Machines	Prof. G.Bhuvaneshwari	IIT Delhi

Computer Usage / Software required: Simulink/ Matlab

EEC-402: DIGITAL ELECTRONICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Engineering mathematics, Basic Electronics and Analog Electronics

COURSE OBJECTIVES & COURSE DESCRIPTION: To learn fundamental concepts in classic manual digital design and also learn how digital circuits are designed using CAD tools in modern times.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Examine the number systems, perform the arithmetic and operations, basic gates and their hardware realization.
CO2	Illustrate reduction of logical expressions using Boolean algebra, k-map and tabulation method
CO3	Design and analyze Combinational Circuits for given Application
CO4	Design and analyze synchronous and asynchronous sequential circuits using flip flops
CO5	Understand register, counters and their uses for various applications

UNIT-I: Introduction to Language of Digital System, Number System, Arithmatic/logical operations, Codes for discrete elements of information, Digital Logic gates, Digital Logic Families – Introduction to RTL, DTL, TTL, ECL and MOSL families- operation, Characteristics, comparison of different logic families, ADC, DAC, simulations of digital circuits

UNIT-II: Boolean algebra, switching algebra, representation of Boolean functions in sum of products form (SOP) and product of sums (POS) form, minimization of Boolean functions using Karnaugh map Problem solving.

UNIT III: Combinational logic circuits: Analysis of logic circuits, Design of logic circuits: Arithmetic operation, Code converters, Comparators, Decoders, encoders, applicationsMultiplexers, de-multiplexers, applicationsBuffers, tri-state buffers and their applications

UNIT-IV: Sequential Logic circuits: Latches –SR, D, Flip-Flops- D FF, JK flip-flop, T-flip-flop, Synchronous Sequential Logic circuits - state table and excitation tables - state diagrams – Analysis of synchronous sequential circuits, Moore and Mealy models - state reduction and state assignment, Design of clocked sequential circuits, Counters-ripple, synchronous, design of counters.

UNIT-V: Registers: Shift registers, parallel, serial, universal, Asynchronous sequential logic circuits: Introduction, Analysis procedures, circuits with latches, Design, reduction of state and flow tables, race Free State assignment, hazards.

Additional topics: Data sheet
Logic gate ICs:7400,7XXX,7404,7408,7432.7486; Multiplexer ICs:74151, 74153 ; Decoder IC 74138; BCD to 7 segment decoder IC:7447; Flip-flop ICs:7474,7476; Asynchronous Counter ICs: 7490,7492,7493; Synchronous counter ICs: 74190,74192,74193, Register ICs:7491,7495,74195

TEXTBOOKS:

[T1] M. Morris Manno, “Digital Design”, Pearson Education (Singapore) Pte. Ltd, Indian Branch, Patparganj, Delhi-110092, India.

[T2] Donald P Leach, Albert Paul Malvino, Goutam Sha, ‘Digital Principles and Applications’, Tata McGraw Hill, 7th Edition, 2010.

REFERENCE BOOKS:

[R1]. Tocci R.J., Neal S. Widmer, ‘Digital Systems: Principles and Applications’,Pearson Education Asia, 2014.
[R2]. Herbert Taub and Donald Schilling, “Digital Integrated Electronics”, McGraw Hill Book Co.

WEB RESOURCE:

[W1]. https://www.youtube.com/watch?v=BDq8-QDXmekM
[W2]. https://nptel.ac.in/courses/108/105/108105132/

EEC-403: POWER ELECTRONICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Pre requisites:

COURSE OBJECTIVES & COURSE DESCRIPTION: The course objectives for an undergraduate (UG) Power Electronics course typically aim to provide students with a fundamental understanding of power electronics and its applications. These objectives include the following topics to be taught : Introduction of Power Electronics, Semiconductor devices, Power semiconductor switching, Converter topologies, control techniques etc.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain basics of Power electronics, device operation and its control.
CO2	Analyze the operation of uncontrolled and fully control rectifiers along with expressions of fourier series
CO3	Apply the circuit topology to get the operation of DC-AC converters and AC-AC converters and its application
CO4	Understand the process of operation of DC-DC converters along with its control
CO5	Discuss various control techniques and few advance topics with understanding of related simulation software.

UNIT-I: Introduction, Devices: Diodes-silicon, fast recovery, Schottky diode, SCR,TRIAC, SCS, GTO, PUT, SUS, CUJT, LASCR, Mosfet, IGBT with their V-I characteristics. SCR: Operating principle, Gate Characteristics, Two transistor model, over-current and over voltage protection, snubber circuits, methods of turning on (triggering) and turning off (commutation).

UNIT-II: Half-wave and full-wave controlled rectifiers with resistive and reactive load, battery load Freewheeling diode. Detailed derivation of rms, average value, harmonic factor, displacement factor, THD, crest factor. Three phase half wave and full wave controlled rectifiers. Effect of Source impedance.

UNIT III: Voltage-driven inverter, current-driven inverter, Single-phase inverter with resistive load, inductive load, Zero current switching (ZCS), Zero voltage Switching (ZVS). Introduction of resonant inverters. Three phase bridge inverter, 120-180 degree conduction. Multi level inverter, AC Voltage Controllers: Single and three phase ac voltage controllers. Cycloconverters: Single phase to single-phase, three-phase to single-phase, three-phase to three-phase cycloconverter circuit and their operation.

UNIT-IV: Principle of chopper, Step down-Step up chopper, Step down chopper with RL load withoutlinear approximation, Chopper classification: First Quadrant, Second Quadrant, Third and Fourth Quadrant, Fourth Quadrant, All Four Quadrant Chopper. Buck, Boost, Buck-boost DC-DC converters. Bidirectional DC-DC converter.

UNIT-V: Various control techniques for power electronics converters: Various PWM Techniques, Advance applications: Power Factor correction, Solar PV technology, Motor drive, Electric Vehicle, FACTS, AI for power electronics, Simulation software: PSIM, Real time HIL. UPS, Energy harvesting WSN.

TEXTBOOKS:

[T1] M. H. Rashid, “Introduction to Power Electronics- Circuits, devices and application”, Pearson Education India, New Delhi.

[T2] A Haque, M A Khan, K V S Bharath, “Design and Control of Grid connected PV System” CRC Press, USA.

REFERENCE BOOKS:

[R1] P. C. Sen, “Power Electronics” Tata McGraw Hill Book Co., New Delhi.

[R2] G. K. Dubey, S.R. Doradla, A.Joshi and R.M.K. Sinha, “Thyristorised Power Controllers” ,Wiley Eastern Ltd., New Delhi.

WEB RESOURCE:

[W1] www.nptel.ac.in

ASM-401: ENVIRONMENTAL SCIENCE

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2	0	0	2	Mid Sem.40%+ End Sem.60% =100%	MC-III	30

Course Outcome:

CO1	To develop an understanding of water, its quality, properties and treatment in industries
CO2	To understand the chemistry of corrosion, its types and protection from it.
CO3	To study and understand about the basics of environment and pollution.
CO4	To study and understand about various hazardous wastes in the environment and their management.
CO5	To develop knowledge and understanding of biotechnology.

UNIT - I: WATER TREATMENT:
Hardness, types of hardness and its Units. Determination of hardness by EDTA method. Alkalinity of water & its significance, Numerical problems. Problems with boiler feed water and its treatment; Scale & Sludge formation, Boiler corrosion, Caustic Embrittlement, Priming & foaming, Softening methods; Lime-soda, Zeolite & Ion Exchange processes, Numerical problems.

UNIT- II: CORROSION AND ITS PROTECTION:
Corrosion; Definition and its scope, Chemical Corrosion, Electrochemical Corrosion, Types of Corrosion; Intergranular Corrosion, Soil Corrosion, Waterline Corrosion, Differential Aeration Corrosion, Galvanic and Concentration Cell Corrosion, Factors affecting corrosion, Protection of corrosion.

UNIT - III: ENVIRONMENTAL CHEMISTRY:
Environment and its Segments, Zones of Atmosphere, Air Pollution: Air pollutants and their resources; Aerosol and its Types, RSPM, SPM, Acid rain, Green House Effect, Global warming, Ozone Layer Depletion, Water Pollution: sewage Treatment, Determination and Significance of COD, BOD, TOC.

UNIT- IV: WASTE MANAGEMENT:
Definition, types and sources of hazardous waste (Municipal, industrial and biomedical). Need for solid and hazardous waste management. Physical, chemical and biological properties of wastes. Elements of integrated waste management (waste minimization and disposable methods).

UNIT-5: ENVIRONMENTAL BIOTECHNOLOGY:
Biotechnology and its applications, Fermentation, Production of alcohol and vitamins, Biological indicators, Biosensors, Bioremediation, Bio-fertilizers, Bioreactors, Biodiversity and its conservation.

Reference Books:

1. S.C. Sharma, “Environmental Engineering”, Khanna Publishing House
2. R.C. Gaur, “Basic Environmental Engineering”, Newage Publications
3. P.N. Modi, “Water Resources Engineering”, Standard Publishers
4. Dr. A.K. Jain, “Environmental Engineering”, (ISBN: 978-93-86173560), Khanna Publishers

AST-401: OPERATIONS RESEARCH

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Prerequisite: Strong foundation in mathematics: Calculus. Linear Algebra, Probability and Statistics. Familiarity with computer programming

COURSE OBJECTIVES & COURSE DESCRIPTION: This foundational course introduces you to the powerful tools and techniques used to make optimal decisions in a variety of complex, real-world situations. It will facilitate to understand core concepts like modelling, optimization, and uncertainty in making impactful decisions.

COURSE OUTCOME: After successfully completing the course, students should be able to

CO1	Understand operational research and its general methodology.
CO2	Formulate problems and solve it with Integer programming.
CO3	Formulate problems and solve it with Goal programming, understanding the queuing system and concepts with basic numerical.
CO4	Understand simulation and its applications to decision making under uncertainty
CO5	Understand network development and project management with Project time management using CPM & PERT

UNIT - I
Nature and development of operations research, OR general methodology, applications of OR to industrial problems. Formulation of linear programming, deterministic models Linear Optimization Models: Graphical solutions. Simplex algorithm, computational procedure in simplex, duality and its concept, elementary sensitivity analysis, Application of Linear Programming. Application of LINDO, LINGO and related software for solving optimisation problems.

UNIT- II
Integer Programming: Relationship to linear programming (LP), Formulating IP models, Solving IP Problems: Branch-and-Bound, Cutting Plane Method.
Transportation problems; methods for obtaining the solution, degeneracy in transportation problems. Stepping stone method. Trans-shipment problems. Assignment problems.

UNIT - III:
Goal Programming (GP): Definition and purpose of GP, Comparison with other optimization techniques (LP, IP), Formulation and Solution Techniques of Goal Programming Models Queuing Problems: Queuing systems and concepts; classification of queuing situations; Kendall's notation, solution of queuing problems. single channel, single stage, finite and infinite queues with Poisson arrival and exponential service time; applications to industrial. problems.

UNIT- IV
Simulation: Introduction, reasons for using simulation, limitations of simulation. Steps in simulation process. Application of simulation. Computer simulation. Monte Carlo simulation. Sequencing, n jobs two stations, two jobs n stations and graphical method. Decision Theory.

UNIT-5
Network development, Gantt chart. Project Critical path scheduling. construction of a CPM network, the critical path. Float calculations. Project Evaluation and Review Technique and its calculations. Network applications in operations management, Project crashing and resource allocation. Newer Network methods. Mathematies I, II and III.

TEXTBOOKS:

[T1] Operations Research Introduction, Taha, H.A., Pearson Education. India

REFERENCE BOOKS:

[R1] Quantitative Techniques for Decision Making, Gupta MP, Prentice Hall of India.
[R2] Introduction to Operations Research by Hillier and Lieberman, Tata McGraw Hill, India

Computer Usage / Software required: MS Project 2000 (and Prima Vera), Operation research software like LINDO, LINGO, SOLVER SUIT, EXCEL etc.

AST-402: ENGINEERING ECONOMICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Prerequisite: Basic Mathematics

COURSE OBJECTIVES & COURSE DESCRIPTION: The course introduces concepts and economic analysis procedures to assist with decision making in engineering analysis. Concepts include demand and supply. time value of money and cash flow diagrams, simple, compound, nominal, and effective interest rate: single and series payments. Methods to compare project alternatives include present, future, and annual worth, and rate of return analysis Methods to forecast demand include extrapolative, explanatory and judgemental methods. It also provides an introduction to different depreciation methods.

COURSE OUTCOME: After successfully completing the course, students should be able to

CO1	Interpret the significance of engineering economy, demand and supply, and market structure.
CO2	Apply the basic principles of the time value of money and its application to draw the cash-flow diagrams (CFD) and to compute equivalent values for time based cash flows of varying complexities.
CO3	Select and apply different standard methods for economy studies.
CO4	Evaluate different alternatives using the economy study methods to design the best one for considered application.
CO5	Suggest, customize and implement the most suitable forecasting, depreciation.

UNIT - I
Introduction to engineering economy. Definition, the economic environment. methodology and application, Principles of engineering economy, Steps in engineering economic analysis. Cost concepts and its application to break-even analysis, Basies of demand, supply and equilibrium. Price elasticity of demand. Income elasticity of demand. Cross elasticity of demand, Market structure Perfect competition, Monopoly, Monopolistic competition and Oligopoly

UNIT- II
Interest and money-time relationship: Simple and compound interest, notation and cash flow diagram, the concept of equivalence. Interests formulas for discrete compounding and discrete cash flows relating present and future worth of single cash flows and uniform time series (annuity), deferred annuities. annuities with beginning of period cash flows, equivalent present worth, future worth and annual worth, Interest formulas relating an arithmetic gradient series to its present and annual worth, Nominal and effective interest rates, interest problems with uniform cash flows occurring less often and more often than compounding periods. Increasing and decreasing gradients.

UNIT - III:
Basic methods of making economic studies: Present worth (P.W. method. annual worth (A. W.) method, future worth (F.W.) method, internal rate of return (I.R.R.) method, external rate of return (E.R.R.) method, explicit reinvestment rate of return (E.R.R.R.) method.

UNIT- IV
Selection among alternatives: alternatives having identical (or not known) revenues and lives, Alternatives having identical revenues and different lives, Selection among independent alternatives.

UNIT-5
Demand estimation and forecasting: Basic categories of forecasting method. Extrapolative methods. simple average. moving average and exponential smoothing. Errors involved in forecast. Explanatory methods, regression analysis for linear forecaster, coefficient of determination and correlation. Qualitative method. Delphi approach. Market survey, Depreciation and depletion: Definition and purpose, types of depreciation, and depreciation.

TEXTBOOKS:

[T1] Principles of Engineering Economics with Applications, Zahid A. Khan, Arshad Noor Suldiquee, Brajesh Kumar, Mustuta 11. Abidi Cambridge University Press, New Delhi, India.

REFERENCE BOOKS:

[R1] Engineering Economy, Degarmo E. Paul, Sullivan William G. And Bontadelli James A. Macmillan Co. of Singapore.
[R2] Engineering Economy, I eyland Blank T. and Tarquin Anthony J. (1989), McGraw Hill Publishing Company Ltd., India
[R3] Engineering Economy. Panneerselvam R Prentice Hall of India.
[R4] Modern Production/Operations Management, Elwood S. Buffa and Rakesh K. Sarin, Wiley India Pvt. Ltd

Computer Usage / Software required: MS EXCEL.

EEL-401: DC AND SYNCHRONOUS MACHINES LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "DC and Synchronous Machines" (EEC-401). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include, load characteristics of DC shunt generator, speed control of DC shunt motor, V-curve of synchronous motor, parallel operation of synchronous generator etc.

EEL-402: DIGITAL ELECTRONICS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Digital Electronics" (EEC-402). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include basic logic gates, half and full adders, parity checkers, multiplexer/demultiplexer, A/D and D/A converters,, various types of flip flops etc.

EEL-403: POWER ELECTRONICS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Power Electronics" (EEC-403). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include study of the characteristics of SCR, different turn ON Methods of SCR, UJT Firing Circuit of SCR, DC-DC Converter, DC-AC Inverter. This laboratory course also familiarizes the students with etc.

ASL-401: NUMERIC AND SCIENTIFIC COMPUTING LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	ECS-L

This laboratory course is designed based on theory course of "Engineering Mathematics". There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. It includes programs for Numerical Integration by Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 rule, Solution of Non-linear, algebraic and transcendental equation in one and two variables by Bisection method, Newton's method, Newton divided difference formula for one point and more than one point, Lagrange's method and Newton's divided difference formula, Gauss Elimination method, Gauss Seidal method, Jacobi method, Runge-Kutta fourth order method etc. using C/C++ Language.

FIFTH SEMESTER COURSES

EEC-501 CONTROL SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Prerequisites: To understand this course, the student must have idea of:

Sl. No.	Subject	Description	Level of Study
01	Mathematics	Linear Differential Equations, Laplace Transform	Class XII, 2nd Sem
02	Physics	Rotational Motion	Class XI
03	Circuit Theory	Network Theory	3rd Sem

COURSE OBJECTIVES & COURSE DESCRIPTION:

- To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
- To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system
- Formulate different types of analysis in frequency domain to explain the nature of stabilityof the system.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form.
CO2	Characterize any system in Laplace domain to illustrate different specification of the system using transfer function concept.
CO3	Interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
CO4	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.
CO5	Formulate different types of analysis in frequency domain to explain the nature of stability of the system.

UNIT-I: Introduction: Concept of feedback and Automatic control, Effects of feedback, Objectives of control system. Types of control systems. Merits and demerits of open and closed loop control systems, Transfer function concept.
Mathematical modeling of dynamic systems: Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring– Mass-Dashpot system. Mathematical modelling of electrical systems. Analogous systems, Force-current analogy, Force –voltage analogy. Mathematical modelling of electromechanical systems. Mathematical modeling of mechanical, electrical, thermal, hydraulic and pneumatic systems.

UNIT-II: Block diagram representation of control systems. Block diagram algebra. Block diagram reduction rules. Overall transfer function of complex block diagrams. Signal flow graph. Mason's gain formula.
Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tacho-generators. Actuators. Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, Servomechanisms and regulators.

UNIT-III: Time domain analysis: Time domain analysis of a first and standard second order closed loop system. Time Response Specifications, Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems.
Error Analysis: Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.

UNIT-IV: Stability Analysis in Time Domain: Stability concept, Necessary conditions for stability. Routh-Hurwitz's stability criterion, Root locus techniques, construction of Root Loci for simple systems. analysis of control system by root loci. Sensitivity of the roots of the characteristic equation. Relative stability analysis. Effects of gain on the movement of Pole and Zeros.

UNIT-V: **Frequency domain analysis of linear system**: Relationship between time and frequency response, Procedure to plot Polar plot, Bode plots, Determination of margin of stability in Bode plot, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin.

TEXTBOOKS:

1) I. J. Nagrath and M. Gopal, "Control Systems Engineering" New Age International Ltd , New Delhi, 7th Edition
2) Norman S. Nise, "Control System Engineering", 7th Edition, Wiley
3) Richard C Drof, Robert H. Bishop, "Modern Control Systems, Pearson, 13th Edition
4) Gopal, M., "Control Systems: Principles and Design", Tata McGraw Hill Book Co., New Delhi.
5) Gopal, M., "Digital Control Systems and State Variable techniques", Tata McGraw Hill Book Co., New Delhi.
6) Kou, B.C., "Automatic Control System", Prentice Hall of India Pvt. Ltd., New Delhi.
7) Ogata, K., "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi.

WEB RESOURCE :

1. https://www.controleng.com
2. https://www.mathworks.com
3. https://nptel.ac.in/courses/108/102/108102043/

EEC-502: SWITCHGEAR & PROTECTION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Fundamentals of Power Systems

COURSE OBJECTIVES & COURSE DESCRIPTION: This course aims to provide students with a comprehensive understanding of power system protection, including its fundamental principles, components, and various aspects of circuit breakers, protective relaying, and protection schemes. By the end of the course, students should be equipped with the knowledge and skills necessary to contribute to the safe and reliable operation of electrical power systems and effectively protect them from various electrical faults and disturbances.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	To understand the qualities and importance of arc and protection of electrical systems i.e. Fuse, isolator.
CO2	To understand the working and testing of various types of circuit breakers and their applications.
CO3	To understand various types of relays (electromagnetic and static etc.) for any electrical system and their need and applications.
CO4	To apply protection schemes for Generator, Transformer, Bus-Zone, Transmission line.
CO5	To understand about lightning arresters and switching surges and the importance of grounding of power system.

UNIT-I: Need for protection system, Elements of power system protection. Fuse, H.R.C. fuse, Isolators, Theory of arc formation, properties of arc, Arc interruption theories. Circuit constants and circuit conditions, Restriking voltage transient Rate of Rise of Restriking voltage(RRRV), Current Chopping, Duties of switch-gear, Resistance switching , Circuit breaker rating.

UNIT-II: Construction and Operation of Air-break circuit breakers (CBs), Oil CBs, Single and Multibreak construction, Air-blast CB, Recent development in circuit breakers, Vacuum Breaker, Sulpher Hexa-flouride CB's, DC circuit breaker, Comparative merits and demerits of CBs.

UNIT-III: Need for protective relaying, Protective Zones, Primary and back up protection, Desirable Properties of protective relaying, Principle and operation of Electromagnetic and Induction type Relays, Relay settings, Directional, Distance, Differential, Overcurrent and earth fault relays, Static Relays, Numerical Relays/IEDs (Intelligent Electronic Devices).

UNIT-IV: Scheme of protection of Generator, Transformer, Bus-Zone, Transmission line. Merz-Price circulating current scheme, Restricted earth fault protection, Negative Sequence Protection, Bucholz relay, Translay scheme, pilot protection.

UNIT-V: Lightning and switching surges, dynamic overvoltages, ground wire, transmission reflection, refraction and attenuation of surges, spark gap, arresters, surge absorbers, BIL, insulation coordination, grounding of power system.

TEXTBOOKS:

[T1] Badri Ram, D. N. Vishwakarma, "Power System Protection and Switchgear, McGrawHill Publishing Co., New Delhi

REFERENCE BOOKS:

[R1] C. R. Masion, "The Art and Science of Protective Relaying", New Age International, New Delhi..
[R2] Haroon Ashfaq, "Switchgear & Protection", Khanna Publishing House, New Delhi.
[R3] Suni S. Rao, "Switchgear and Protection", Khanna Publishers, New Delhi

WEB RESOURCE :

[W1] https://archive.nptel.ac.in/courses/108/107/108107167/
[W2] https://archive.nptel.ac.in/courses/108/105/108105167/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Power System Protection and Switchgear	Prof. Bhaveshkumar R. Bhalja	IIT Roorkee
2.	Power System Protection	Prof. A. K. Pradhan	IIT Kharagpur

EEC-503: ELECTRICAL MEASUREMENT

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: To understand the basic operation of different measurements and thereby able to choose appropriate instruments for measuring different parameters.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand the principle and performance of type of instruments, Methods of measurements, classification of errors, accuracy and precision.
CO2	Understand the principle and performance of PMMC, Moving Iron, induction and dynamometer type measuring instruments.
CO3	Perform the measurement of various electrical engineering parameters like voltage, current, power,energy etc in industry as well as in power generation, transmission and distribution sectors.
CO4	Measurement of power and energy in single phase and three phase circuits. Instruments transformers-Current and Potential transformers.
CO5	Propose and create innovative ideas to improve the existing technology and methodology in the field of measurements in terms of accuracy, cost, and durability and user friendliness rising to the level of societal needs.

UNIT-I: Units, Concepts of measurement- static characteristics of instruments, classification of errors, accuracy and precision, statistical analysis of errors, standards for measurements, temperature, emf, resistance, current, inductance, capacitance. Methods of measurements. Classification of instruments- absolute, secondary, indicating, recording, integrating.

UNIT-II: Instruments for voltage and current measurement, control, balancing and damping forces of instruments, D Arsonval galvanometer- construction and operation, PMMC (Permanent magnet moving coil), moving iron, dynamometer type instruments. Electrostatic and induction type instruments. Use of rectifier for measuring instruments.

UNIT III: Measurement of energy- single phase induction type watt-hour meter and clock meters. Polyphase watt-hour meters. Ac energy meter testing. Meters for special purposes prepayment meters, maximum demand indicator, power factor meter, frequency meter and synchroscope.

UNIT-IV: Power in ac circuits, construction and operation of dynamometer and induction type wattmeter. Measurement of power using wattmeter for single phase circuits and three phase circuits. Measurement of reactive power (CT and PT).

UNIT-V: Extension of range of voltmeter and ammeter. Current transformer (CT) and Potential transformer (PT) - theory, ratio and phase angle error, design considerations, characteristics, effect of power factor, secondary burden. Industrial current sensors (Hall Effect).

TEXT/REFERENCE BOOKS:

[T1] W.D. Cooper, A. D. Helfric, “Electronic Instruments and Measurements”, Prentice Hall of India, New Delhi.
[T2] E.W. Golding, F.C. Widdis, “Electrical Measurements and Measuring Instruments”, JOBS Publications.
[T3] A.K. Sawhney, “A Course in Electrical and Electronic Instruments and Measurements”, Dhanpat Rai and Sons, Delhi.

WEB RESOURCE:

[W1] http://en.wikipedia.org/wiki/signalsandsystems

EEC-504: PROGRAMMING LANGUAGES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Basics of programming, digital electronics

COURSE OBJECTIVES&COURSE DESCRIPTION: The course objectives for an undergraduate (UG) Student to make him capable to interpret the concept of programming with Python language with the knowledge of how to express the conditional execution of Python Language. Student will be able to determine the operation with Functions in Python and will be able to identify the operations for working of MATLAB & SIMULINK. Student will articulate the programming concept for integration of MATLAB and Python.

COURSE OUTCOMES: After successfully completing the course, student will be able to:

CO1	Student will be able to Interpret the concept of programming with Python language
CO2	Student will have the knowledge of how to Express the conditional execution of Python Language.
CO3	Student will be able to determine the operation with Functions in Python.
CO4	Student will be capable to Identify the operations for working of MATLAB & SIMULINK.
CO5	Student will Articulate the programming concept for integration of MATLAB and Python.

UNIT-I: Introduction of Programming: What is programming, building blocks of programming, Syntax error, Logic error, Semantic errors, debugging, what is Python: Basic, variable, expression and statements, operators and operand

UNIT-II: Conditional Execution in Python: Boolean expression, Logical Operators, Conditional execution, Alternating Execution, creating a variable, Chained Conditionals, Nested Conditionals, Exception- try and Concept,

UNIT III: Functions in Python: Built-in Function, Conversion Function, Math Function, Random Numbers, Fruitful and Void Function, Iteration, String, Regular Expressions, Loops, Conditional Logic and Control Flow, Tuples, List, Object Oriented Programming, Modules and packages,

UNIT-IV: Introduction to MATLAB, applications: Polynomial in MATLAB, solving equations, numerical integration, differential. Graph and Figure plotting, Handling graphics window, plotting 2D and 3D graphs. File input and output: Opening and closing files, writing formatted output to files, reading formatted data from files, Introduction to Simulink.

UNIT-V: MATLAB/Simulink with Python: Differences Between Python and MATLAB, Common Packages: Load Data, Data Visualization, Save Data; Calling Python from MATLAB, MATLAB application in Python, Simulink model and Code Generation.

Additional topics: GUI with MATLAB, Python

TEXTBOOKS:

[T1] Charles R Severance "Python for Everybody", Realpython.com/pybasics python
[T2] David Kuncicky, "MATLAB Programming", Pearson Education, 2003

REFERENCE BOOKS:

[R1] Manaullah Abid, Programming in C, MATLAB and Simulink,
[R2] Alexandre Chabot-Leclerc, Migrating MATLAB® to Python: Strategies, Comparisons and a Guide to Converting, Enthought, Inc

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Principle of Programming	Prof. S. A. Kumar	IIT Delhi
2.	Python for Data Science	Prof. R. Rengasamy	IIT Madras

Computer Usage / Software required: Operating Systems (Windows, Linux etc.)/Anaconda, PyCharm etc.

EEC-505: FUNDAMENTALS OF POWER SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: EE-101: Basics of Electrical Engineering

COURSE OBJECTIVES & COURSE DESCRIPTION: This course aims to give an overview of power system and its various components, calculation of line parameters, evaluation of line performance, mechanical aspects of overhead transmission line, underground cables, their constructional features and current rating, sub-stations and its various equipments, and their grounding and testing.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	To understand and evaluate the various parameters of transmission line
CO2	To represent different types of transmission lines with their equivalent mathematical model and to evaluate their performance
CO3	To understand different effects in transmission line and evaluate the string efficiency.
CO4	To identify the different types of cables and poles used in transmission line and calculate the sag.
CO5	To recognize different types of sub-stations, sub-station components, sub-station earthing and to familiarize with testing of installation.

UNIT-I: Line parameters, Resistance, calculation of Inductance of single-phase and three-phase line with equilateral and un-symmetrical spacing. transposition, GMD, GMR, Capacitance calculation of two wire and three-phase lines with symmetrical and un-symmetrical spacing, Skin effect, Proximity effect.

UNIT-II: Representation of short and medium lines. Nominal Tee-Pie method. Solution for long line. ABCD parameters. Receiving and sending-end voltages. Regulation and efficiency.

UNIT-III: Ferranti effect, Corona, disruptive critical voltage, visual corona, corona power-loss. Interference between power and communication circuits. Types of insulators and their constructional features. Potential distribution in string of suspension insulator. Methods of equalizing the potential. String efficiency. Single and bundle conductors.

UNIT-IV: Types and construction of cables, insulation resistance of a cable, capacitance and grading in cables, current rating of a Power Cable, dielectric stress. Overhead lines versus underground cables. Types of towers and poles used. Standard clearance. Sag calculations in conductor suspended on level supports and supports at different levels. Effect of wind, ice, tension and sag at erection.

UNIT-V: Substation classification, layout, scheme of bus-bar arrangement, single line diagram of typical substation showing location of different components and their functions, grounding and testing of installation.

TEXTBOOKS:

[T1] C. L. Wadhwa, "Electrical Power System", New Age International, New Delhi.
[T2] S.N. Singh, "Electric Power Generation, Transmission and Distribution", Second Edition, PHI Learning New Delhi.

REFERENCE BOOKS:

[R1] William D. Stevenson, Jr.,"Elements of Power Systems Analysis", McGraw Hill Book Co., Singapore.
[R2] I. J. Nagrath and D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Co., New Delhi.
[R3] Ashfaq Hussain, "Electrical Power Systems", Fifth Edition, CBS Publishers & Distributors, New Delhi.
[R4] H. Cotton and Barber, "The Transmission and Distribution of Electrical Energy", Third Edition, B.I. Publications Pvt. Ltd., New Delhi.

WEB RESOURCE:

[W1] https://nptel.ac.in/courses/108105067
[W2] https://archive.nptel.ac.in/courses/108/104/108104051/
[W3] https://nptel.ac.in/courses/108105104

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Power System Engineering	Prof. Debapriya Das	IIT Kharagpur

EEE-501: COMMUNICATION SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Engineering Mathematics, Basic Electronics, Signals and Systems

COURSE OBJECTIVES & COURSE DESCRIPTION: This course aims to develop a strong foundation in the principles of analog and digital communication, enabling them to comprehend and work with a wide range of communication systems and technologies

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand Amplitude modulation and Demodulation systems
CO2	Understand Frequency modulation and Demodulation systems
CO3	Understand Pulse modulation and Demodulation systems
CO4	Understand Radio transmitter and Receiver systems
CO5	Understand modern communication system

UNIT-I: Modulation: Need for modulation. Principle of Amplitude modulation. Modulation index and power calculations. SSB-SC, DSB-SC and vestigial side band modulations. Generation and detection of SSB-SC, DSB-SC and VSB signals, calculation of power.

UNIT-II: Principals of frequency and phase modulation, frequency deviation and modulation index. Narrow band and wide band frequency modulations and their frequency spectra, Carlson's rule for bandwidth calculation. Generation of Narrow-band and Wide-band FM waves. Armstrong method, direct and indirect methods of FM generation. Demodulation of FM signals.

UNIT-III: Pulse Modulation: Sampling theorem, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM), their generation and detection. Pulse code modulation (PCM), quantization, encoding, quantization error, companding DPCM. Delta-modulation and adaptive delta modulation, time-division multiplexing.

UNIT-IV: TRF receiver, disadvantages of TRF receiver, super-heterodyne, advantages. Performance of radio receivers, sensitivity, image frequency and its rejection, double spotting, AGC, AFC, AM and FM transmitters, their elementary circuits and block diagram representations.

UNIT-V: Modern communication Systems: Introduction to optical communication system, optical fiber v/s metallic cable, Types of optical fiber: step index and graded index, multimode and single mode. Introduction to satellite communication and Mobile communication system.

TEXTBOOKS:

[T1] Simon Haykin, "Communication Systems", New Age International, New Delhi. Dec 2008.
[T2] B. P. Lathi, "Modern Digital and Analog Communications Systems", New Age International, New Delhi, 2010.

REFERENCE BOOKS:

[R1] George Kennedy, "Electronic Communication Systems", McGraw Hill Book Co., Singapore, 2015.
[R2] Herbert Taub and Donald L. Schilling, "Principles of Communication Systems", McGraw Hill, Kogakusha Ltd., Tokyo, 1998
[R2] Wayne Tomasi, "Electronics Communication System", Pearson Education Indi, 2007.

WEB RESOURCE:

[W1] https://archive.nptel.ac.in/courses/108/104/108104091/
[W2] https://nptel.ac.in/courses/117102059

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Principles of Communication Systems - I	Prof. Aditya K. Jagannatham	IIT Kanpur
2.	Principles of Communication Systems - II	Prof. Aditya K. Jagannatham	IIT Kanpur

EEE-502: PROGRAMMABLE LOGIC CONTROLLER (PLC)

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Digital Electronics

COURSE OBJECTIVES & COURSE DESCRIPTION: The students will have the knowledge and skills necessary to work with a variety of PLC systems, create automation programs in different languages, and utilize timers, counters, and SCR devices for solving real-world industrial automation challenges.

COURSE OUTCOMES: After successfully completing the course, students will be able to:

CO1	Identify different types, modules, of PLCs of different vendors
CO2	Write programs in different PLC languages
CO3	Use different Timers in the field.
CO4	Use counters in design of various programs
CO5	Apply SCR in complex automation problems

Unit-I: PLC BASICS

The PLC: A look inside, General PLC programming Procedure, Devices to which PLC Input and Output Modules are connected: Input On/Off Switching Devices, Input Analog Devices, Output On/Off Devices, Output Analog Devices.

Unit-II: PLC Programming

Programming On/Off inputs to Procedure on-off outputs, Relation of Digital Gate to Contact/Coil logic, Creating Ladder Diagrams from Process Control Descriptions: Introduction, Ladder diagrams and sequence listings, Large Process Ladder diagram construction, Flowcharting as a programming Method.

Unit-III: PLC Functions

Register Basics: Introduction, General characteristics of Registers, Module addressing, Holding Registers, Input registers and Output Registers. PLC Timer Functions: Introduction, examples of Timer Function Industrial Applications, Industrial Process Timing Application. PLC Counter Functions: Introduction, PLC Counters with examples.

Unit-III: Intermediate Functions

PLC Arithmetic Functions: Introduction, PLC addition and subtraction, repetitive clock, PLC multiplication, division and square root, Trigonometric and Log function. PLC Number Comparison: Introduction, Basic comparison Function, its application. Numbering System: Intro to Decimal, Binary, BCD, Octal and Hexadecimal number system.

Unit-V: Data Handling Functions and Controlling a Robot with PLC

The PLC SKIP and Master Control Relay Functions, JUMP Functions, PLC data move system, PLC FIFO function, One Shot(ONS) and Clear (CLR). Controlling Robot: Intro, basic two axis robot with PLC sequencer control, Industrial three-axis Robot with PLC control.

TEXTBOOKS:

[T1] Programmable Logic Controllers: Principles and Applications, Fifth Edition, Prentice Hall, 2006.
[T2] PLC Programming For Industrial Automation by Kevin Collins.

REFERENCE BOOKS:

[R1] Programmable Logic Controllers by William Bolton, Newnes/Elsevier, 2010.

WEB RESOURCE :

[W1] https://nptel.ac.in/courses/108105063/
[W2] https://nptel.ac.in/courses/112102011

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Industrial Automation and Control	Prof. S. Mukhopadhyay	IIT Kharagpur

Computer Usage / Software required: Siemens software/Interface model for Siemens PLC/Compiler

EEE-503: ELECTROMAGNETIC FIELD THEORY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Mathematics-I, and Engineering Physics

COURSE OBJECTIVES & COURSE DESCRIPTION: This course is to provide students with a comprehensive understanding of electromagnetic phenomena and their applications. The syllabus is organized into units, covering topics such as vector analysis, electrostatics,

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	calculate electric field intensities produced by various charge distributions, including continuous volume charge distributions, line charges, and sheet charges, using Coulomb's law and related principles
CO2	understand and apply concepts related to electric flux density, Gauss's law, symmetrical charge distributions, electric potential, and energy density in electric fields
CO3	calculate capacitance for various configurations and solve Poisson's and Laplace's equations with appropriate boundary conditions
CO4	proficient in applying laws related to steady magnetic fields, including Biot-Savart's law and Ampere's circuital law, and calculating forces and torques on moving charges and closed circuits in magnetic fields.
CO5	Proficient in applying Maxwell's equations to analyze electromagnetic waves, including understanding wave propagation, Poynting vectors, and intrinsic impedance for different media

UNIT-I: Vector Analysis, coordinate systems, vector operator, curl, divergence theorem, Stoke's theorem, Coulomb's law, electric field intensity, field due to continuous volume charge distribution, field of a line charge, field of a sheet of charge.

UNIT-II: Electric flux density, Gauss's law, symmetrical charge distributions, differential volume element, divergence, Maxwell's first equation, energy expended in moving a point charge in an electrostatic field, line integral,

UNIT III: Current and current density, continuity of current, metallic conductors, conductor properties and boundary conditions, semiconductors, nature of dielectric materials, boundary conditions for perfect dielectric materials, capacitance, several capacitance examples, capacitance of two wire line, Poisson's and Laplace's equations, unique Theorem, examples of the solution of Laplace's and Poisson's equations, product solution of Laplace equation.

UNIT-IV: Boit Savart law, Ampere's circuital law, magnetic flux and magnetic flux density, scalar and vector magnetic potentials, derivations of steady magnetic field laws, force on a moving charge, force on differential current element, force between differential current elements, force and torque on a closed circuit.

UNIT-V: Faraday's law, displacement current, Maxwell's equations in point forms and in integral forms, Application of Maxwell's equations, EM waves and propagation of energy. Wave equation for free space. Plane and uniform plane wave. Poynting vector and power, Intrinsic impedance of media for uniform plane wave.

TEXTBOOKS:

[T1] N.Narayana Rao, "Elements of Engineering Electromagnetics", Prentice Hall of India Pvt. Ltd., New Delhi
[T2] William H. Hayt (Jr.), "Engineering Electromagnetics", McGraw Hill Book Co., New Delhi.
[T3] Matthew N.O. Sadiku and S.V. Kulkarni, "Principles of Electromagnetics" 6th edition, Oxford University Press,2015

REFERENCE BOOKS:

[R1] Joseph A. Edminister, "Electromagnetics", Schaum's Outline Series in Engineering, McGraw Hill Co., New Delhi
[R2] E. Norman lurch, "Fundamental of Electronics", John Wiley and Sons, New York, USA.

WEB RESOURCE: https://onlinecourses.nptel.ac.in/noc23_ee96/preview

EEE-504: UTILIZATION OF ELECTRICAL ENERGY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: To understand the principles of electric traction,train movement and speed time curve, electric heating and welding and their requirements, design the lighting schemes for residential, commercial and industrial applications.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand the system of electric traction, mechanics of train movement and speed time curve and concept of electric breaking.
CO2	Understand the railway track system, operating principle, characteristics and control of traction motor.
CO3	Study the basics principle of illumination, types of electric source and different lighting system.
CO4	Understand the principle of electric heating, its advantages and different type of heating and furnaces.
CO5	Understand electric welding and electrolytic process

UNIT-I: Introduction, general features, track specification, arrangement of locomotive drives, transmission of power from motor to driving wheel. Mechanics of train movement, speed time curves, tractive effort for acceleration and propulsion, power and energy output from driving axel.

UNIT-II: Train resistance, adhesive weight, and coefficient of adhesion, Feeding and distributing system for tramways and railways, Track arrangements, collector gears and auxiliary equipment's, Diesel-electric equipment's, characteristics, transmission of drive, electric transmission. Review of traction motors and their control, comparative features of ac and dc traction, Recent trends in electric traction, Magnetic Levitation Systems.

UNIT III: Nature of light, definitions, units, basics laws of illumination, determination of luminous flux, Light sources and their characteristics, light production by excitation and ionization, incandescence and fluorescence, sources of light-filament lamp, halogen lamp, sodium vapour lamp and neon lamp, fluorescent lamp, incandescent lamp, arc lamp and their applications, LED lighting and energy efficient lamp, Direct lighting and mixed reflection, reflection factor, transmission factor, refractors, lighting fitting, street lighting, exterior and interior lighting. Energy Conservation Building Code, Bureau of Energy Efficiency star- rating for lamps.

UNIT-IV:Advantages of electric heating, resistance heating, types of furnaces, types of heating materials, temperature control of furnaces, variable voltage supply, design of heatingelement, arc furnace, induction heating, dielectric heating, microwave oven, domestic water heaters and other heating appliances and thermostat control circuit.

UNIT-V:Electric welding- classification, welding equipment, electric supply for arc welding, resistance welding, comparison between AC and DC welding, welding transformer, welding techniques, Faraday's law of electrolysis, Electrolytic Process- Basic principles, electro-deposition, electrolysis, electric supply for electrolysis.

TEXT/REFERENCE BOOKS:

[T1] H. Partab, Art and science of utilization of electrical energy, Pritam, Surat and brothers,New Delhi.

[T2]. N. N. Hancock, Electric power utilization, Wheeler Publications, Allahabad

[T3]. Soni, Gupta and Bhatnagar, Electric power utilization, Dhanpat Rai and sons, New Delhi.

[T4]. E. Openshaw Taylor, Utilization of electrical energy, Orient Longman Publishers.

[T5]. C. L. Wadhwa, Generation, distribution and utilization of electric energy, New AgePublications, New Delhi.

EEE-505: DATA STRUCTURES AND ALGORITHMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, etc.

Pre requisites: Computer & Programming Fundamentals, digital electronics and C/C++

COURSE OBJECTIVES&COURSE DESCRIPTION: To introduce the concept of data structures including arrays, linked lists, stacks, queues, binary trees, heaps, binary search trees, and graphs etc., and apply these data structures in problem solving. To introduce applications of various data structures and its use in a manner that adds to the efficiency of an algorithm in writing effective programs.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Learn how the choice of data structures and algorithm design methods impact the performance of programs.
CO2	Analyze the importance and use of Abstract Data Types (ADTs)
CO3	Analysis the different types linked list and its applications.
CO4	Understand and analysis the different type of trees.
CO5	Understand the different graph and explain best, average, and worst-cases of an algorithm using Big-O notation.

UNIT-I: Concept of Data Structures, Basic Terminologies related to data structures, linear and non-linear data structure. Concept and properties of algorithms, How to develop an algorithm, Complexity, Time-Space Tradeoff, Algorithm analysis.

UNIT-II: Stack as a ADT, operations on stack, Stack implementation using array and linked list, Applications of Stack: Polish and reverse Polish notations, Recursion, Garbage collection. Queue as ADT, Operations on queue, and Types of queues: Linear Queue, Circular Queue, Priority Queue, and Double Ended Queue, Applications of Queue.

UNIT III: Concept of a Linked List, Linear Single and Double link lists, Circular Single and Double link List, Generalized Linked List, Header Linked list, Applications of Link List.

UNIT-IV: Concepts of a Tree, Tree as ADT, Definitions of n-ary, binary trees, Terms associated with trees. Operations on tree, Tree Search Algorithms, Binary Search Tree, Tree traversal Algorithms, AVL Trees, Threaded binary trees, Heap Tree, Expression tree, Huffman Tree, B – Tree and B+ Tree.

UNIT-V: Graph Traversal – BFS, DPF, Graph algorithm-Warshall's, Djikastra's, Minimum Spanning Tree – Prim's and Kruskal's Algorithm. Sorting Algorithms-Sequential Sort, Shell Sort, Insertion Sort, Merge Sort, Quick Sort, Topology sort. Rate of growth: Big Oh notation, other asymptotic notations for complexity of algorithms. Computing Complexity of Algorithms.

TEXTBOOKS:

[T1] Data Structure, Seymour Lipschutz, Schaumn Series, Tata McGraw publications.
[T2] An Introduction to Data Structure with Applications by Trem bley and Sorenson, McGraw Hill Education.
[T3] Data Structures Using C by Aaron M Tenenbaum, Prentice Hall International, 1996.
[T4] Algorithmic Learning by Alan Hutchinson, Oxford University Press, USA, 1994.
[T5] Introduction to Algorithms by Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, MIT Press; 3rd edition, September, 2009.

REFERENCE BOOKS:

[R1] Fundamentals of Data Structure in C by Horowitz, Sahniand Anderson-Freed,University Press.
[R2] Data Structure and Algorithm–John Beidler, Springer.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Data Structure and Algorithm	Prof. Hema Murthy	IIT Madras
2.	Programming and Data Structure	Prof. P.P Chakraborty	IIT Kharagpur

Computer Usage / Software required: Operating Systems (Windows, Linux etc.) and programming language.

EEE-508: COMPUTER ARCHITECTURE

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Computer & Programming Fundamentals, Logic gates and Combinational Circuits

COURSE OBJECTIVES&COURSE DESCRIPTION:

This course aims to give an understanding of the mechanisms for implementing the programmer's idealized computer. It introduces students to the fundamental concepts underlying modern computer architecture, how computers work and how to analyze their performance. The course aims to describe a broad range of architectural designs and to contrast them, highlighting the design decisions they incorporate. The designs are described and analyzed at the register-transfer level of abstraction. The course has an emphasis on understanding concurrency and issues affecting modern computers and recent advances in the processors.

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COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Explain the basics of organizational and architectural issues of a digital computer and classify and compute the performance of machines and analyze arithmetic for ALU implementation.
CO2	Describe the basics of hardwired and micro-programmed control of the CPU, pipelined architectures, Compare and contrast the various forms of pipeline hazards.
CO3	Analyze the performance of various classes of Memories, build large memories using small memories for better performance
CO4	Describe various data transfer techniques in digital computer and the I/O interfaces
CO5	Explain MIMD, multicore organizations, CUDA and basic elements of GPU architecture.

UNIT-I: Architecture of a computer system, Classes of Computers, Measuring, Reporting, and Summarizing Performance, Quantitative Principles of Computer Design, Computer Arithmetic: ALU, Integer Representation, Integer Arithmetic, Floating Point Representation, Floating Point Arithmetic.

UNIT-II: Fundamentals of designing a processor: instruction set, Processor Structure & Functions, Control Unit, Microprogrammed Control, Technique of segmentation (pipeline): Operation, Associated Concepts: Latency and Performance (Throughput); Processor Design with pipeline, Limitations of the pipelined instructions channel: Causes of performance loss due to stop of pipeline, Techniques to avoid halts.

UNIT III: Memory Organization and Structure, Memory Hierarchy, Internal Memory, External Memory, Cache Memory, Basic principles of the cache: Multi-level Cache, Organizations, Operating schemes, Replacement Algorithms, Cache Coherence, Examples of Caches, Virtual Memory, Integration of the Memory.

UNIT-IV: External Devices, I/O Modules, Programmed I/O, Interrupt Driven I/O, Direct Memory Access, Direct Cache Access, I/O Channels and Processors, External Interconnection Standards.

UNIT-V: Instruction level parallelism, Superscalar Processors, VLIW Processors, Multicore, Multiprocessors and Clusters: Hardware and Software Performance Issues, Shared memory Multiprocessors, Clusters and other message-passing Multiprocessor; Introduction to Graphics Processors.

TEXTBOOKS:

[T1] J. L. Hennessy and D. A Patterson, “Computer Architecture: A Quantitative Approach”, 5th ed. Morgan Kaufmann, 2012. ISBN: 978-0-12-383872-8.
[T2] William Stalling, “Computer Organization and Architecture: Designing for Performance” , 10th ed., Pearson, 2016. ISBN: 978-0-13-410161-3
[T3] M. Morris Mano, “Computer System Architecture”, 3rd ed, Pearson, 2013
[T4] Computer Organization, Carl Hamacher, ZvonkoVranesic, SafwatZaky, Fifth Edition, McGraw Hill.

REFERENCE BOOKS:

[R1] Memory System - Cache, DRAM and Disk Bruce Jacob, Spencer W. Ng, David T. Wang Morgan Kaufman, 2007.
[R2] Principles and Practices of Interconnection Networks William J. Dally, Brian P. Towles Elsevier, 2003.
[R3] John P.Hayes, ‘Computer architecture and Organization’, Tata McGraw- Hill,Third edition, July 2017.
[R4] Computer Organisation and Architecture, Smruti R. Sarangi, McGrawHill (2015)

WEB RESOURCE :

[W1] https://www.coursera.org/learn/comparch
[W2] https://www.mooc-list.com/tags/computer-architecture

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Computer Architecture	Prof. S.R. Sarangi	IIT Delhi
2.	Multi-Core Computer Architecture	Prof. John Jose	IIT Gauwhati

EEE-510: DIGITAL SIGNAL PROCESSING

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Engineering Mathematics, Basic Electronics, Signals and Systems

COURSE OBJECTIVES & COURSE DESCRIPTION: This course aims to strengthen the students with the foundation in digital signal processing, enabling them to apply their knowledge to a wide range of engineering and technical applications. It also aims to enable the students to design digital filter and its realization.

COURSE OUTCOMES: After the successful completion of the course, students will be able to:

CO1	Understand the operations on digital signals
CO2	Design the systems required for digital signal processing.
CO3	Design and analyze FIR digital Filter.
CO4	Design and analyze IIR digital Filter.
CO5	Design and analyze of Optimal Filters.

Unit-I: Discrete time signals, Linear convolution and Circular convolution of two finite length signals. Discrete time systems; their classification, transfer function and realization. Steady state response of discrete time systems. Stability analysis.

Unit-II: Discrete Fourier Transform and its properties. Functional operation with DFT, convolution and correlation. Introduction to radix-2 FFT, decimation in time and decimation-in-frequency radix-2 algorithm.

Unit-III: IIR Filters: Properties of IIR digital filters, Design of IIR filters from continuous time filters – Impulse invariance and Bilinear transformation technique. Design of Butterworth and Chebyshev digital filters. Elementary ideas of finite word length effects in digital filters.

Unit-IV: FIR Filters: Amplitude and phase response of FIR filters. Linear phase filters. Window and rectangular window. Finite length impulse response by truncation. Gibb's Phenomenon. Windowing technique for the design of linear phase FIR filters – Rectangular Hamming, Hann and Kaiser Windows . Examples of Filter designs using windows.

Unit-V: Digital filter sampling: Frequency sampling techniques. Design procedure using frequency sampling. Introduction to optimal filters. Optimal FIR filter design. Frequency transformations. Filter design using frequency transformations.

TEXTBOOKS:

[T1] Johnny H. Johnson, 'Introduction to Digital signal Processing', PHI Learning Publications, New Delhi, 2015.
[T2] S. Esakkirajan, T. Veerakumar, Badri N Subudhi, " Digital Signal Processing", McGraw Hill Education (India) Private Limited, 1st edition, 2021.
[T3] Alan V. Oppenheim and Ronald W. Schafer, " Digital Signal Processing", Pearson Education India; First Edition, January 2015.
[T2] John G Proakis, Dimitris K Manolakis, 'Digital Signal Processing', Prentice Hall International, 4th Edition, 2007.

REFERENCE BOOKS:

[R1] Rabiner & Gold, 'Theory and Applications of Digital Signal Processing', PHI Learning Publications, 1st Edition, 2009..
[R2] Oppenheim and Schaffer, 'Discrete Time Signal processing', Pearson Education Publications, 3rd Edition, 2010.

WEB RESOURCE :

[W1] https://nptel.ac.in/courses/117102060
[W2] https://archive.nptel.ac.in/courses/108/105/108105055/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Digital Signal Processing	Prof. C. S. Ramalingam	IIT Madras
2.	Digital Signal Processing and its Applications	Prof. V. M. Gadrei	IIT Bombay

EEE-511: INTRODUCTION TO ROBOTICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, etc.

Pre requisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: This course introduces the basics of robotics to students. It enables to students to understand robot kinematics and applications. It also introduces different types of sensors used in robot applications.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Understand the basics of robot.
CO2	Understand the kinematics and control of robots.
CO3	Select different types of sensors used in robot applications
CO4	Understand the applications of robots in various sectors

UNIT-I: Robot Basics
Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot. ROBOT ELEMENTS End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

UNIT II: Robot Kinematics and Control
Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming

UNIT III: Robot Sensors
Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

UNIT IV: Robot Applications
Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications.

TEXT/REFERENCE BOOKS:

[T1] Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, “Industrial Robotics Technology, Programming and Applications”, Tata –McGraw Hill Pub. Co., 2008.
[T2] Deb. S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
[T3] Klafter. R.D, Chmielewski.T.A, and Noggin’s., “Robot Engineering: An Integrated Approach”’, Prentice Hall of India Pvt. Ltd., 1994.
[T4] Fu. K.S, Gonzalez.R.C&Lee.C.S.G, “Robotics control, sensing, vision and intelligence”, Tata- McGraw Hill Pub. Co., 2008
[T5] Yu. “Industrial Robotics”, MIR Publishers Moscow, 1985.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Robotics: Basics and Selected Advanced Concepts	By Prof. Ashitava Ghosal	IISc Bangalore

Computer Usage / Software required: ROS, Matlab/Simulink

EEL-501 CONTROL SYSTEMS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of " Control Systems " (EEC-501). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include study of performance characteristics of potentiometer error detector, linear system simulator, DC motor speed control system Synchro transmitter -receiver system, magnetic amplifier system different tyes of controllers etc.

EEL-502: SWITCHGEAR & PROTECTION LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Switchgear and Protection" (EEC-502). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include over current, under voltage, differential relays, microprocessor based relays, string efficiency, and A, B, C, D parameters of transmission line, and VAR compensator etc.

EEL-504: PROGRAMMING LANGUAGES LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Programming Languages" (EEC-504). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include MATLAB/Python programming for electrical engineering problems.

EEL-505: POWER SYSTEMS COMMUNICATION LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Communication Systems " (EEE-501). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include application of communication systems in power systems such as amplitude modulation, frequency modulation etc..

SIXTH SEMESTER COURSES

EEC-601 ADVANCED CONTROL SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, etc.

Prerequisites: Basic knowledge of Sampling and design of control system with different techniques, and mathematics, matrix algebra.

COURSE OUTCOMES: At the end of this course students will demonstrate the ability to:

CO1	Proficient in designing compensators for system performance enhancement using tools such as Bode diagrams, Root Locus plots, and the intersection method.
CO2	Proficient understanding and application of various controller types (P, I, PI, PD, PID) and tuning methods, including Ziegler-Nichols, for optimal performance in industrial control systems.
CO3	Proficient in state-variable analysis, including representation, conversion between transfer functions and state variables, and understanding controllability and observability concepts, for effective control system analysis and design.
CO4	Proficient in state-space design methodologies, encompassing regulator design, pole placement techniques, and observer design for both continuous and discrete control systems.
CO5	Proficient in digital control systems, encompassing sampling, signal analysis, Z-transform, state variable representation, stability analysis, and controller design for efficient system operation.

UNIT-I: Compensator Design: Improvement of system performance through compensation. Fundamentals of compensator design in time and frequency domain. Desired performance specifications based Cascade and feedback Compensation – Design of Lag, Lead, Lag-Lead Compensator using Bode Diagram and Root Locus Plot. Intersection method.

UNIT-II: Controller Design: Introduction to Proportional (P) action, Integral action, PI controller for first order system, Proportional derivative integral Controllers (PID), P, PI, PD and PID controller design methodology, PID controller tuning methods, Ziegler Nichols tuning methods. Introduction to Industrial Controllers.

UNIT-III: State Variable Analysis: Concept of state, State-variable, State model, State models for linear continuous-time function, control system analysis using state-variable methods, state variable representation, conversion of state-variable modes to transfer functions, conversion of transfer function to canonical state variable models, solution of state equation, concepts of controllability and observability. Equivalence between transfer function and state variable representation.

UNIT-IV: Design using state space approach: State regulator design, output regulator design, pole placement technique, Gain matrix by Ackerman's formula, Design example. Observer design, full order observer, reduced order observer

UNIT-V: Digital Control Systems: Review of Sampling theorem, Spectrum analysis of sampling process, Signal reconstruction, Pulse transformation, Z- transform analysis of sampled data system, Block diagram reduction. State variable representation of digital control system, State transition equation, Solution of state equation by z- transform technique, Non-Linear Control System

TEXT/REFFERENCE BOOKS

1) I. J. Nagrath and M. Gopal, "Control Systems Engineering" New Age International Ltd., New Delhi, 7th Edition
2) Norman S. Nise, "Control System Engineering", 7th Edition, Wiley
3) Richard C Drof, Robert H. Bishop, " Modern Control Systems, Pearson, 13th Edition
4) Gopal, M., "Control Systems: Principles and Design", Tata McGraw Hill Book Co., New Delhi.
5) Gopal, M., "Digital Control Systems and State Variable techniques", Tata McGraw Hill Book Co., New Delhi.
6) Kou, B.C., "Automatic Control System", Prentice Hall of India Pvt. Ltd., New Delhi.
7) Ogata, K., "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi.

WEB RESOURCE :

1. https://www.controleng.com
2. https://www.mathworks.com
3. https://nptel.ac.in/courses/108/102/108102043/

EEC-602: ELECTRICAL & ELECTRONICS INSTRUMENTATION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, etc.

Pre requisites: Electrical Measurement, Analog Electronics, Circuit Analysis

COURSE OBJECTIVES & COURSE DESCRIPTION: The course deals with measurement of resistance, inductance, Capacitance and frequency. Further, it comprises Instrumentation part that deals with transducers, and transducer based instrumentation systems. Objective of the course is to make students aware of different transducers and different components of transducer based measurement systems.

Further, this course provides an opportunity to the students to study Research Articles/Papers appearing in various Journals and learn about the latest developments in the Instrumentation. Basis for design of this syllabus is topics covered in GATE, ESE and topics related to industrial applications.

COURSE OUTCOMES: After successfully completing the course:

CO1	Students will be able to select and design/implement suitable method for measurement of resistance of different ranges.
CO2	This course will familiarize the students with different kind of ac bridges and their applications in measurement of inductance capacitance and frequency
CO3	This course will make students to understand different kind of transducers and will be able to design/ implement transducer based measurement systems
CO4	Students will be aware of magnetic measurements and separation of core losses and further students will be able to use oscilloscope in stable signal presentation and measurements.
CO5	This course will make students to understand construction and working of different kind of useful electronics and digital instruments and latest developments in the field of measurement and instrumentation.

UNIT-I: Classification of resistance and measurement challenges. Measurement of medium resistance- voltmeter ammeter method, substitution, Wheatstone bridge methods and Ohmmeters. Measurement of low resistance voltage drop method, potentiometer method, Kelvin double bridge method, necessary precautions for precision and accuracy. Measurement of high resistance- direct deflection method, loss of charge method and Meg-ohm bridge.

UNIT-II: Maxwell's bridge, Hay's bridge, Anderson bridge, De Sauty's bridge, Modified De Sauty's bridge, Schering bridge and Wien bridge. Application of ac bridges in measurement of resistance, capacitance, inductance, mutual inductance and frequency.

UNIT III: Classification of transducers, Transducers: RTD, thermistor, thermocouple, strain gauge, LVDT, Piezoelectric transducer. Application of transducers in measurement of pressure, force, temperature, speed and other industrial parameters. Signal conditioning issues; Signal level and bias adjustment, linearization, conversions, filtering, Basic instrumentation amplifier.

UNIT-IV: Magnetic measurements, magnetometer, ballistic galvanometer, flux meter, Hall-effect devices (flux measurement). Separation of iron losses, methods of iron loss measurement. Working and construction, application in measurement voltage and current (ac and dc), significance of lissajous figures in measurement of frequency and phase angle. Other measurement applications of oscilloscope.

UNIT-V: Electronic voltmeters, digital voltmeter (DVM), multimeters, Q-meter, spectrum analyzer, ultrasonic measurements, introduction to data acquisition, Recent developments in field of Measurements & Instrumentation.

TEXTBOOKS/REFERENCE BOOK(S):

1. Golding and Widdis, Electrical measurements & measuring instruments, Wheeler Books.
2. David A Bells, Electronics Instrumentation and Measurements, Oxford University Press India; Third edition (12 April 2013)
3. D. Helfrick and W. D. Cooper, Modern Electronic Instrumentation and Measurement Techniques.
4. A. K. Sawhney, Electrical & Electronic Measurements and instrumentation, Dhanpat Rai & Sons, 2009.
5. H S Kalsi, Electronic Instrumentation, TMH Publications, 2012

Web Resources:

[1] https://onlinecourses.nptel.ac.in/noc19_ee44/preview
[2] https://archive.nptel.ac.in/courses/108/105/108105064/

EEC-603: POWER SYSTEM ANALYSIS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Fundamentals of Power systems

COURSE OBJECTIVES & COURSE DESCRIPTION: This course aims to equip students with a comprehensive understanding of power transmission and distribution systems, network representation, load flow analysis, fault analysis, and the application of computer tools in solving practical power system problems, enabling them to excel in the field of electrical engineering and contribute to the efficient and reliable operation of electrical networks.

COURSE OUTCOMES: After successfully completing the course, students should be able:

CO1	To understand and compare various power transmission and distribution schemes, including DC and AC systems
CO2	To apply per unit system to develop power system network models.
CO3	To formulate load flow problem and perform load flow study of a power system network.
CO4	To understand different types of faults and analyze symmetrical three phase fault
CO5	To apply sequence network interconnections to analyze various types of faults

UNIT-I: Typical transmission and distribution scheme. DC 2-Wire and 3-wire, A.C single-phase, 3-phase and 4 wire system, comparison of copper efficiency, Kelvin's law, D.C. distributor fed at one end, three wire D.C. distributor fed at one end, distributor fed at both ends, uniformly loaded distributor, ring mains, stepped mains, A.C. distribution. Standard voltages and advantages of high voltage transmission. Comparison of D.C. and A.C. transmission

UNIT-II: One line diagram, impedance and reactance diagram, per unit representation of single phase and three phase system, change of base, per unit impedance of a transformer, Network model formulation, Formulation of Y-Bus and Load flow equation formulation, Classification of Buss.

UNIT-III: Load Flow Solution Techniques, Gauss-Siedal method, Newton-Raphson method, Fast decoupled load flow equation, comparison of solution methods. Introduction to computer calculations of load flow problems.

UNIT-IV: Symmetrical 3-phase fault. Short-circuit current and reactance of synchronous machines. Fault current in unloaded systems. Internal voltage of loaded machines. Short-circuit currents by method of internal voltage and Thevenin's theorem. Symmetrical components of three-phase unbalanced phasors, Power in terms of symmetrical components, Phase-shift in Star-Delta transformer banks, Sequence impedance and sequence network. Zero-sequence equivalent circuits for various three-phase transformer connections.

UNIT-V: Inter-connection of sequence network for various faults: line-to-ground fault, line-to-line fault, double-line to ground fault, Fault through impedance. Introduction to computer calculations of fault current problems.

TEXTBOOKS:

[T1] Hadi Saadat, "Power System Analysis", Tata McGraw Hill Publishing Co., New Delhi.

REFERENCE BOOKS:

[R1] William D. Stevenson, Jr., "Elements of Power Systems Analysis", McGraw Hill Book Co., Singapore
[R2] H. Cotton and Barber, "The Transmission and Distribution of Electrical Energy", Third Edition, B.I. Publications Pvt. Ltd., New Delhi.
[R3] I. J. Nagrath and D.P. Kothari, "Modern Power System Analysis", Tata McGraw Hill Publishing Co., New Delhi.
[R4] J. C. Das, 'Power System Analysis, 'Short-Circuit Load Flow and Harmonics', Marcel Dekker Inc., First Edition, 2002.

WEB RESOURCE :

[W1] https://nptel.ac.in/courses/108105067
[W2] https://archive.nptel.ac.in/courses/108/104/108104051/
[W3] https://archive.nptel.ac.in/courses/108/107/108107127/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Power System Analysis	Prof. A. K. Sinha	IIT Kharagpurr
2.	Power System Analysis	Prof. Arindam Ghosh	IIT Kanpur

Computer Usage / Software required: MATLAB

EEC-604: SCADA AND SMART GRID TECHNOLOGIES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	PCC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites:

(i) Basic understanding of the electrical power system's structural components.
(ii) Basic understanding of Utilization of electrical energy
(iii) Basic understanding of Operation & control aspects of Engineering Systems.
(iv) Basic understanding of the Analog & Digital Data communication and computer networks.

COURSE OBJECTIVES & COURSE DESCRIPTION:

- To understand Supervisory Control and Data Acquisition (SCADA) systems and the components
- To understand the use of SCADA systems in Power systems
- To understand the smart grid concept, realize smart grid benefits and identify the challenges in smart grid implementation.
- Exploring the smart grid optimization solutions and their impact on the grid.
- To explore the smart digital substations and understand smart Transmission concepts, including Phasor measurement units (PMUs).
- To understand the smart Distribution constituents, application functions, advanced metering Infrastructure and demand response
- To understand the role of Information and Communication Technologies in smart grid applications.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Identification of SCADA and its components and their use in Power systems
CO2	Identification and formulation of the Smart Grid Optimization solutions and the status in India
CO3	Knowledge of the new digital substation, Smart transmission systems and PMUs.
CO4	Knowledge of smart distributing solutions, application functions, AMI and demand response
CO5	Knowledge of different communication protocols and their impact on the smart grid operation.

Unit-I: Automation Systems, Supervisory Control & Data Acquisition (SCADA) Systems, Components of SCADA Systems, Remote Terminal Unit (RTU)/Intelligent Electronic Devices (IEDs), Communication systems, Master Station & Human Machine Interface, Application of SCADA in Power Systems.

Unit II: Evolution of Smart Grid, Components of Smart Grid, Old Vs New Grid, Challenges & Opportunities, Smart Grid benefits, Smart Grid solutions, Status of Indian Electricity System, Markets, Case Studies.

Unit-III: Substation Automation, Substation LAN, Substation Communication Architecture, The new Digital Substation, Wide area monitoring systems (WAMS), Phasor Measurement Unit (PMU), Applications, Grid Automation Initiatives-Case Studies.

Unit-IV: Distribution Automation, Subsystems, Application functions-Voltage/VAR Control, Power Quality, Network Reconfiguration, Demand side management, demand Response, Advanced Metering Infrastructure (AMI), Smart meters, Smart Appliances, Home Automation Systems.

Unit-V: ISO OSI 7 layers communication Reference Model, TCP/IP Model, SCADA communication requirements, SCADA communication system topologies, SCADA and Smart Grid communication protocols- Modbus, IEC60870-5-101/103/194, DNP3, IEC 61850, Communication Security, Challenges

TEXT/REFFERENCE BOOKS:

1. Mini S. Thomas and John Douglas McDonald, "Power System SCADA and Smart Grids" CRC Press-2015.
2. Stuart Borlase, "Smart Grids, Infrastructure, Technology and Solutions, CRC Press-2013
3. James Momoh, "Smart Grid, Fundamentals of Design and Analysis", IEEE Press, John Wiley & Sons, 2012.
4. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & Sons, 2012.

EEE-601: MICROPROCESSOR AND MICROCONTROLLER

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Engineering Mathematic, Basic Electronics and Analog Electronics

COURSE OBJECTIVES & COURSE DESCRIPTION:

- The Students will acquire the basic knowledge about 8086 Microprocessors.
- The Students will acquire the basic knowledge about 8051 Microcontroller
- The Students will learn about interfacing of 8086 microprocessor wirh I/O devices.
- The Students will learn about interfacing of 8051 microcontroller.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand the basics of 8086 microprocessor
CO2	Comprehend with Assembly language programming fundamentals of the 8086 microprocessor
CO3	Interface the microprocessor with the peripheral devices
CO4	Understand the basics of microcontroller
CO5	Comprehend with programming fundamentals and interfacing of the microcontroller

UNIT-I: THE 8086 MIROPROCESSOR:
Introduction to 8086 — Microprocessor architecture — Addressing modes — Instruction set and assembler directives — Assembly language programming — Modular Programming — Linking and Relocation — Stacks — Procedures — Macros — Interrupts and interrupt service routines — Byte and String Manipulation.

UNIT-II: 8086 SYSTEM BUS STRUCTURE:
8086 signals — Basic configurations — System bus timing –System design using 8086 — I/O programming — Introduction to Multiprogramming — System Bus Structure — Multiprocessor configurations — Coprocessor, Closely coupled and loosely Coupled configurations — Introduction to advanced processors..

UNIT III: I/O INTERFACING:
Memory Interfacing and I/O interfacing — Parallel communication interface — Serial communication interface — D/A and A/D Interface — Timer — Keyboard /display controller — Interrupt controller — DMA controller — Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.

UNIT-IV: MICROCONTROLLER:
Architecture of 8051 — Special Function Registers(SFRs) — I/O Pins Ports and Circuits — Instruction set — Addressing modes — Assembly language programming..

UNIT-V: INTERFACING MICROCONTROLLER:
Programming 8051 Timers — Serial Port Programming — Interrupts Programming — LCD & Keyboard Interfacing — ADC, DAC & Sensor Interfacing — External Memory Interface- Stepper Motor and Waveform generation — Comparison of Microprocessor, Microcontroller, PIC and ARM processors

TEXTBOOKS:

[T1] Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096 by Krishna Kant; published by Prentice Hall of India, April 2013.
[T2] James L. Antonakes, "An Introduction to the Intel Family of Microprocessors", Published by Pearson Education Asia, Third Edition, 2001.
[T3]Advanced Microprocessors and Interfacing: Intel 8086 to Pentium 4 Processors by Badri Ram; published by Tata McGraw Hill Company Ltd. 2000.
[T4]Microprocessors: Theory and Applications, by M. Rafiquzzaman; published by Pearson Education Asia, First Edition, 2016.

REFERENCE BOOKS:

[R1] A text of Microprocessors and Microcontrollers by R.S. Kaler published by I.K. International Publishing house Pvt. Ltd., New Delhi, India, 2011.

EEE-602: HVDC TRANSMISSION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites:

COURSE OBJECTIVES&COURSE DESCRIPTION:
This course aims to provide students with a comprehensive understanding of HVDC (High Voltage Direct Current) transmission technology. Students will learn to compare and contrast DC and AC transmission, analyze HVDC converters, design filters to manage harmonics, and explore HVDC cables and simulation tools. The curriculum spans five units, covering the basics of DC transmission, converter analysis, regulation, harmonics, and cable technology. Upon completion, students will be well-equipped to comprehend, analyze, and design components within HVDC transmission systems, preparing them for careers in the electrical power industry.

COURSE OUTCOMES: After successfully completing the course,

CO1	Student will understand the concept, planning of DC power transmission and comparison with AC power transmission.
CO2	Student will be able to analyze HVDC rectifier circuits.
CO3	Student will be able to analyze HVDC inverters.
CO4	Students will be able to effectively analyze harmonics and design of filters.
CO5	Student will learn about HVDC cables and simulation tools.

UNIT-I: Introduction of DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Planning for HVDC transmission – Modern trends in DC transmission

UNIT-II: Pulse number – Choice of converter configuration – Simplified analysis of Graetz circuit– Converter bridge characteristics – Characteristics of a twelve pulse converter –Detailed analysis of converters.

UNIT III: General – Required regulation – Inverter compounding – Uncompounded inverter –Rectifier compounding – Transmission characteristics with the rectifier and inverter compounding – Communication link – Current regulation from the inverter side –Transformer tap changing.

UNIT-IV: Introduction – Generation of harmonics – Design of AC filters and DC filters –Interference with neighboring communication lines.

UNIT-V: Introduction of DC cables – Basic physical phenomenon arising in DC insulation –Practical dielectrics – Dielectric stress consideration – Economics of DC cables compared with AC cables. Introduction to system simulation – Philosophy and tools –HVDC system simulation – Modeling of HVDC systems for digital dynamic simulation.

TEXTBOOKS:

[T1] Padiyar, K. R., "HVDC power transmission system", Wiley Eastern Limited, NewDelhi 2019. First edition.
[T2] Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Wiley interscience,New York, London, Sydney, 1971.

REFERENCE BOOKS:

[R1] Colin Adamson and Hingorani N G, "High Voltage Direct Current PowerTransmission", Garraway Limited, London, 1960.
[R2] Arrillaga, J., "High Voltage Direct Current Transmission", Peter Pregrinus, London,1983.
[R3] Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", NewAge Interantional (P) Ltd., New Delhi, 1990.

WEB RESOURCE :

[W1] www.nptel.ac.in

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	High Voltage DC Transmission	Dr. S.N. Singh	IIT Kanpur

EEE-603: ELECTRICAL POWER GENERATION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Basic Knowledge of thermal science.

COURSE OBJECTIVES & COURSE DESCRIPTION:
This course provides a comprehensive understanding of electrical power generation. Students will learn to analyze cost factors, load characteristics, and different power plant technologies, including thermal, nuclear, and hydroelectric. They will explore coordinated operation methods and emerging renewable energy sources such as wind, solar, and geothermal power. This knowledge equips students to make informed decisions in power generation, addressing cost efficiency, load optimization, and sustainability in the evolving energy landscape.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Acquire a comprehensive understanding of electricity market and tariffs.
CO2	Analyze characteristics for effective thermal and hydro power generation.
CO3	Proficiency in thermal and hydro of Renewable energy sources.
CO4	Understand the benefits and operation of different Renewable power generation technologies.
CO5	Explore innovative and sustainable energy solutions, including advanced technologies.

UNIT-I: Cost of Power Generation: running cost and fixed cost, Method for providing for depreciation factor affecting cost of generation. Load Factor, Load Curve, Demand Factor, Diversity Factor. plant capacity factor and plant use factor. Tariffs: Maximum Demand and Power Factor, Tariff Economics of Power Factor improvements.

UNIT-II: Thermal Power Plants and its Components. Selection of site. Layout of Plant, Pollution Control Equipment's. Elements of Nuclear Power Plant. Nuclear Reactor- it's components and their functions. Types of Nuclear Reactor.

UNIT III: Hydro-Electric Power Plant: Selection of site. Classification, Types of Turbines and their characteristics, Advantages of coordinated operation of different types of power plants, hydro-thermal scheduling – short term and long term. Plant Coordination Algorithms.

UNIT-IV: Introduction of renewable energy sources, their advantages and disadvantages. Challenges of power generation from renewable energy sources. Solar radiation, availability, and measurements. Introduction to power generation from solar thermal systems and application of solar thermal generation, photovoltaic system for power generation, I-V and P-V characteristics of a solar cell, PV arrays and panel sizing. Wind resource assessments and forecasting, site assessment, power in wind, general theories of wind machines, wind energy conservation systems (WECS).

UNIT-V: Recent advances in renewable power generation sources such as hydrogen, fuel cell, energy storage, hybrid and integrated energy systems.

TEXTBOOKS:

[T1] M. V. Deshpandae, "Elements of Electrical Power Station Design", A. H. Wheeler and Co. Pvt. Ltd. Allahabad.
[T2] B. G. A. Shrotzki and W. A. Vopal, "Power Plant Engineering and Economics", McGraw Hill Book Co.

REFERENCE BOOKS:

[R1] C. L. Wadhwa," Generation Distribution and Utilization of Electrical Engineering", New Age International, New Delhi.
[R2] C. L. Wadhwa, "Electrical Power Systems", New Age International, New Delhi.

WEB RESOURCE :

[W1] www.nptel.ac.in
[W2] www.power-eng.com

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Power System Generation, Transmission and Distribution	Prof. D.P. Kothari	IIT Delhi

EEE-604: ROBOTICS AND AI

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Basic knowledge control system.

COURSE OBJECTIVES & COURSE DESCRIPTION: This course provides a comprehensive understanding of robotics and the application of artificial intelligence in robotics. This course introduce robotics perception the students. It also develops the skills of controlling the robot in students.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand the foundational principles of robotics and AI, including key concepts, algorithms, and architectures in both fields.
CO2	Apply machine learning and AI techniques to solve problems related to robot perception, decision-making, and control.
CO3	Analyze and evaluate various robotic systems, understanding their performance, limitations, and the real-world challenges they address.
CO4	Design and implement intelligent robotic systems that can interact with their environment and perform tasks autonomously.
CO5	Create integrated solutions by combining AI, machine learning, and robotics to solve complex real-world challenges in autonomous systems.

UNIT-I: Introduction to Robotics and Artificial Intelligence

Overview of Robotics: History, Evolution, and Applications, Fundamentals of AI and Machine Learning
Components of Robotics: Sensors, Actuators, and Control Systems, Robotics Kinematics: Forward and Inverse Kinematics, Types of Robots: Mobile Robots, Industrial Robots, Humanoids, and Collaborative Robots, Introduction to Robot Operating Systems (ROS), AI Algorithms in Robotics: Search Algorithms, Heuristics, and Optimization.

UNIT-II: Robotics Perception

Computer Vision for Robots: Image Processing, Object Recognition, Feature Detection, Sensors and Perception: LIDAR, Cameras, IMUs, and Ultrasonic Sensors, Sensor Fusion and Kalman Filtering, SLAM (Simultaneous Localization and Mapping) Techniques, Depth Estimation and 3D Mapping, Visual Servoing and Robot Vision in Dynamic Environments, Audio and Speech Processing for Robotics

UNIT III: Robot Control and Motion Planning

Control Systems in Robotics: PID Control, State-Space Models, Path Planning Algorithms: A*, Dijkstra, RRT (Rapidly-exploring Random Tree), Trajectory Planning and Optimization, Robot Localization: Monte Carlo Localization, Particle Filters, Autonomous Robot Navigation in Unknown Environments, Human-Robot Interaction (HRI) and Control Interfaces, Advanced Motion Control: Force and Impedance Control, Adaptive Control.

UNIT-IV: Artificial Intelligence for Robotics

Machine Learning for Robotics: Supervised, Unsupervised, and Reinforcement Learning
Deep Learning and Neural Networks in Robotics: Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Reinforcement Learning in Robotics: Q-Learning, Policy Gradient Methods, Decision Making and Planning: Markov Decision Processes, Partially Observable Markov Decision Processes (POMDPs), Multi-Robot Systems and Swarm Robotics, AI for Autonomous Vehicles: Perception, Localization, Planning, and Control, AI for Robot Behavior Modeling and Task Allocation.

UNIT-V: Advanced Topics in Robotics and AI

Robot Learning: Imitation Learning, Transfer Learning, Online Learning, Human-Robot Collaboration: Shared Autonomy, Cognitive Robotics, Robotics in Industry 4.0 and Manufacturing Automation, Ethics and Safety in AI and Robotics, AI and Robotics for Healthcare: Surgical Robots, Assistive Robots, Autonomous Robotics in Unstructured Environments (e.g., Space, Underwater), Current and Future Trends: Soft Robotics, Bio-inspired Robots, and Quantum Robotics.

TEXTBOOKS:

[T1] Introduction to Robotics: Mechanics and Control by John J. Craig, Pearson.
[T2] Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig, Pearson.
[T3] Robotics: Control, Sensing, Vision, and Intelligence by K.S. Fu, R.C. Gonzalez, and C.S.G. Lee, McGraw-Hill.

REFERENCE BOOKS:

[R1] Machine Learning for Robotics and Computer Vision by K.S. Rajasekaran, Springer..
[R2] Robotics: Modelling, Planning, and Control by Bruno Siciliano and Lorenzo Sciavicco, Springer.
[R3] Deep Learning for Robotics by Fabio Smeraldi, Packt Publishing.

WEB RESOURCE :

[W1] www.nptel.ac.in

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Robotics: Basics and Selected Advanced Concepts	By Prof. Ashitava Ghosal	IISc Bangalore

Computer Usage / Software required: ROS, Matlab/Simulink

EEL-602: ELECTRICAL MEASUREMENT & INSTRUMENTATION LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Electrical Measurement & Instrumentation " (EEC-602). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include Kelvin double bridge method, Wheatstone bridge method, Schering bridge method, Owen bridge method, B-H curve, temperature transducer, strain, RTD, LVDT etc.

EEL-603: POWER SYSTEM ANALYSIS LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Power System Analysis" (EEL-603). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include load flow analysis using different methods, types of fault analysis, and determination of ABCD parameter of transmission lines using MATLAB.

EEL-604: SCADA AND SMART GRID TECHNOLOGIES LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of " SCADA and Smart Grid Technologies" (EEC-604). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include study of hardware and software architecture of SCADA, integration of Field Model with I/O of RTU, LAN for SCADA lab, and GUI for system operator.

EEL-605: MICROPROCESSOR AND MICROCONTROLLER LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PCC-L

This laboratory course is designed based on theory course of "Microprocessor and Interface" (EEE-601). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include 2's complement of 16-bit numbers, addition and subtraction of two 8-bit numbers, decimal addition, multiplication and division of 8-bit numbers, ascending and descending order of a series etc.

EEP-601: SEMINAR

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	PROJ

All the students of Semester VI will be required to deliver a seminar on the topic relevant to recent trends in Electrical Engineering using power point presentation. Topics are selected in consultation with their supervisors. Every student has to present the progress of their works of about 15 minutes duration before the duly constituted committee of Faculty Members of the department followed by a question answer session. The assessment by the committee members are a part of Mist Term Evaluation. A report of the seminar in the form of hard copy must also be submitted in the office before the final evaluation by External Examiners.

SEVENTH SEMESTER COURSES

EEE-701: POWER SYSTEM OPERATION AND CONTROL

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Case studies, Group discussion, Seminar & field work etc.

Course Objectives&Course Description:
This course aims to provide students with advance topics in power system operation & control; both commercial and technical aspects are included. Students will gain understanding of economic dispatch scheduling, importance of constancy of frequency and voltage in the context of power system operating states analysis is also explained. Both conventional and advanced techniques used to maintain voltage profile are taught. Implementation of Automatic Generation Control (AGC) in modern power systems operation is discussed with a thorough understanding of dynamics and stability of a power system. Advanced topics like FACTS and HVDC are also included in this course.

COURSE OUTCOMES: After the completion of the course, the students will be able to:

CO1	Develop generation dispatching schemes for all thermal units.
CO2	Apply control and compensations schemes on a power system.
CO3	Realize the requirements and methods of real and reactive power control in power system
CO4	Understand the basic stability considerations of power system and investigate transient stability issues of single and multiple synchronous machines in power systems.
CO5	Understand the basic concepts of FACTS and HVDC Transmission.

UNIT-I: System constraints, Economic dispatch neglecting losses, Optimal load dispatch including transmission losses, Exact transmission loss formula, Coordination equation, Automatic load dispatching.

UNIT-II: Methods of voltage control, VAR compensation, Reactive power injection and Control by transformers, Power flow through transmission line, Receiving-end and Sending-end power circle diagrams, Universal power circle diagram.

UNIT III: Introduction to automatic generation and voltage control, Speed governor, Turbine and Power system modeling, Load Frequency Control (LFC), Single area case, Automatic voltage control.

UNIT-IV: Introduction, Rotor dynamics, Swing equation, Power angle curve, Steady state stability, Transient stability, Equal area criterion (Sudden change in mechanical input, sudden loss of one of the parallel lines, sudden short-circuit on one of the parallel lines), Point-by-point solution of the swing equation, Multi-machine stability studies, Factors affecting transient stability, Effect of grounding on stability, Prevention of steady-state pullout.

UNIT-V: Flexible AC transmission, Series and Shunt Compensation schemes, HVDC transmission, Limitation and advantages, Classification of DC links, Back – to – back and bulk power supply systems. Recent developments in field of FACTS and Power Electronics.

TEXTBOOKS:

[T1] I. J. Nagrath and D. P. Kothari, 'Modern Power System Analysis', Tata McGraw Hill Publishing Co., New Delhi.

REFERENCE BOOKS:

[R1] William D. Stevenson Jr, 'Elements of Power System Analysis', Tata McGraw Hill Publishing Co., New Delhi.
[R2] C. L. Wadhwa, 'Electrical Power System', New Age International, New Delhi.
[R3] N. G. Hingorani and L. Gyugyi, 'Understanding FACTS', IEEE Press, USA.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Power System Operation & Control	Dr. S N Singh	IIT Kanpur
2.	Computer Aided Power System Analysis	Dr. B. Das, Dr. Vinay Pant	IIT Roorkee
3.	Power System Dynamics and Control	Prof. A M Kulkarni	IIT Bombay

EEE-702: EMBEDDED SYSTEM DESIGN

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Digital Electronics, Microprocessor

COURSE OBJECTIVES & COURSE DESCRIPTION: This course familiarizes the students to the fundamental requirements of embedded systems and the interaction between hardware and software in such systems.

COURSE OUTCOMES: After the completion of the course, the students will be able to:

CO1	Understand about embedded systems.
CO2	Design hardware based embedded systems.
CO3	Understand real time operating systems.
CO4	Understand microcontroller systems.
CO5	Design microcontroller biased system.

UNIT-I: Introduction to embedded systems: Categories of embedded systems, overview of embedded system architecture, characteristics of embedded systems, quality attributes of embedded systems. Factors to be considered in selecting a microcontroller, recent trends in embedded systems.

UNIT -II: Custom Single purpose Processor: RT level combinational components, Design implementation of combinational systems using SSI, MSI and PLDs. RT level sequential components, Design and implementation of sequential systems using Flip-flops. RT level Custom single purpose processor design: basic architecture, data path, control unit.

UNIT -III: Real Time Operating System (RTOS) based Embedded System Design: Operating system basics, Types of operating systems, Tasks, process and threads, Multiprocessing and Multitasking, Task scheduling. Threads, processes and scheduling: putting them altogether. Task communication, Task synchronization, Device Drivers. How to choose an RTOS.

UNIT -IV: Overview of 8051 microcontrollers, Designing with 8051, why 8051 microcontroller, Programming with 8051 microcontroller, different addressing modes supported by 8051 microcontroller., The 8051 instruction sets. Some examples of System design using 8051/8052 microcontroller.

UNIT -V: Introduction to 8051 Timer, Timer SFRs, Timer operating modes, Timer control and operation, using timers as counters, Programming example. 8051 Interrupts, Interrupt sources and interrupt vector addresses, Enabling and disabling of interrupts, Interrupt priorities and polling sequence, Timing of interrupts, Programming examples, 8051 Serial Ports, Serial port control SFRs, Operating modes, Programming serial port, 8051 Interfacing examples.

TEXTBOOKS:

[T1] Embedded System Design- A Unified Hardware/ Software Introduction, Frank Vahid and Tony Givar gis, John Wiley & Sons, Student Edition, Oct-200.
[T2] Introduction to Embedded Systems, Shibu K V, 2nd edition, Tata McGraw Hill, July 2016.

REFERENCE BOOKS:

[R1] The 8051 Microcontroller and Embedded systems, Mazidi M L, Mazidi J G, Mckinlay R D, Pearson Education Inc, New Delhi 2007.
[R2] Digital Design, M. Morris Mano and Michael D. Ciletti, Pearson Education Inc., 2018

WEB RESOURCE :

[W1] https://archive.nptel.ac.in/courses/106/105/106105193/
[W2] https://archive.nptel.ac.in/courses/108/102/108102169/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Embedded Systems Design	Prof. Anupam Basu	IIT Kharagpurr
2.	Introduction to Embedded System Design	Prof. Dhananjay V. Gadre, Prof. Badri Subudhi	NSUT, IIT Jammu

EEE-703: DATA COMMUNICATION AND COMPUTER NETWORKS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Communication system, Information theory, signal and system

COURSE OUTCOMES: The students will be able:

CO1	To analyze and solve issues related to bandwidth, data rate, and noise and make appropriate choices for transmission modes and interface standards.
CO2	To make choices about the transmission media and to decide about the error detection and error correction mechanism.
CO3	To identify and formulate network architectures, OSI reference model, and the Internet along with the associated addressing schemes
CO4	To choose and plan a suitable MAC protocol for LANs.
CO5	To classify and apply an appropriate mechanism for data and network security

UNIT–I: Data Communication System: Introduction, Purpose, Components; Concepts of Frequency, Spectrum, and Bandwidth; Bit Rate and Baud Rate, Bandwidth of a Transmission System, Channel Capacity, Nyquist and Shannon Theorems, Throughput, Latency, Jitter, Transmission Impairments - Attenuation, Distortion, Noise: Modes of Digital Data Transmission,

UNIT–II: Transmission Media: Guided Media - Twisted Pair, Co-Axial Cables, Optical Fiber, Wireless Transmission – Antennas, Use of Frequency Spectrum, Terrestrial Microwaves, Satellite Microwaves, Wireless Propagation- Line-of-sight Transmission, Communication Satellites. Error Detection and Correction: Types of Errors: Single-Bit Error, Burst Error; Block Coding, Process of Error Detection and Error Correction in Block Coding, Parameters of a Coding Scheme, Minimum Hamming Distance for Error Detection and Error Correction, Linear Block Codes, Simple parity Check Code.

UNIT –III: Computer Networks: Network Topologies, IEEE LAN standards, Metropolitan Area networks, Wide Area Networks, Internetworks, Overview of OSI Reference Model, TCP/IP Protocol Suite, Comparison OSI and TCP/IP models, Addressing Schemes, Dotted Decimal Notation, Classful and Classless Addressing, IPv4 and IPv6 addressing.

UNIT –IV: Medium Access Control: Multiple Access Protocols at Data Link Layer, Random Access: ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA), CSMA/CD, CSMA/CA; Controlled Access: Reservation, Polling, Token Passing; Channelization: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA).

UNIT –V: Data and Network Security: Symmetric Key Cryptography, Traditional Cyphers, Substitution Cypher, Shift Cypher, Transposition Cypher, Simple Modern Cyphers, XOR Cypher, Rotation Cypher, Substitution Cyphers, S-box and P-box Cyphers, Modern Round Cyphers; Asymmetric Key Cryptography, RSA and Diffie-Hellman Algorithms; Network Security Services: Message Confidentiality, Message Integrity, message Authentication, Digital Signature.

TEXT/REFFERENCE BOOKS:

1. Andrew S. Tanenbaum, David J. Wetherall,"Computer Networks," 5th Edition, Pearson Education, India, 2012.
2. Behrouz A. Forouzan, "Data Communication and Networking," 5th Edition, Mc Graw Hill, India, 2013.
3. William Stallings, "Data and Computer Communications," 10th Edition, Pearson Education, Inc., NJ

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Data Communication	Prof. Ajit Pal	IIT Kharagpur
2.	Data Communication	Prof. H.S. Jamadagni	IISc Bangalore
3.	Computer Network	Prof. Ajit Pal	IIT Kharagpur

EEE-704: ADVANCED PROTECTIVE RELAYS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Switchgear & Protection

COURSE OBJECTIVES&COURSE DESCRIPTION: The course is designed to provide students with a thorough understating of static relays; its construction operation and application.• It also enables the students to understand the operation of microprocessor based protective relays.

COURSE OUTCOMES: After successfully completing the course, the students will be able to

CO1	Describe the construction of static relay and identify the advantages of static relay over electromagnetic relay.
CO2	Explore the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi input comparators, static differential and distance relays.
CO3	Describe instantaneous, definite time and inverse definite minimum time over current relays.
CO4	Analyze the concept of power swings on distance relays.
CO5	Identify the microprocessor based protective relays and their operation .

UNIT-I: STATIC RELAYS & COMPARATORS
Static relays - Basic construction of Static relays – Level detectors – Replica Impedance-Mixing circuits-General equation for two input phase and Amplitude Comparators – their types – Duality between Amplitude and Phase Comparator –Conic section characteristics–Three input Amplitude Comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes-Phase faults scheme –Three phase scheme–Combined and Ground fault scheme

UNIT-II: TYPES OF STATIC RELAYS
Instantaneous over current relay – Time over current relays - Basic principles - Definite time and Inverse definite time over current relays, directional over current relays - Static Differential Relays-Analysis of static differential relays–Static relay schemes-Dual bias transformer differential protection – Harmonic restraint relay.

UNIT III: NUMERICAL RELAYS
Advantages of Numerical Relays – Numerical network-Digital Signal processing–Estimation of Phasors – Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm- practical considerations for selection of Algorithm– Discrete Fourier Transform

UNIT-IV:. DISTANCE RELAYS AND POWER SWINGS
Static Distance Relays - Static Impedance - reactance - MHO and Angle Impedance relay sampling comparator – Realization of reactance and MHO relay using a sampling comparator.
Effect of power swings on the performance of Distance relays- Power swing analysis - Principle of out of step tripping and blocking relays - Effect of line length and source impedance on distance relays..

UNIT-V: MICROPROCESSOR BASED PROTECTIVE RELAYS
Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flowchart approach only).Generalized mathematical expression for distance relays-Measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) - Basic principle of Digital computer relaying..

TEXTBOOKS:

[T1] T.S. Madhava Rao, Power system Protection static relay, Tata McGrawHill Publishing Company limited, 2nd Edition, 2004.
[T2] Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, Tata McGraw Hill Publication Company limited, 2nd Edition, 2013.

REFERENCE BOOKS:

[R1] Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd Edition, New Delhi, India, 2018.
[R2] Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 1st Edition, 2011.

WEB RESOURCE :

[W1] https://www.nptel.ac.in

Computer Usage / Software required: MATLAB

EEE-705: ELECTRIC DRIVES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Electric machines

COURSE OBJECTIVES&COURSE DESCRIPTION: This course aims to provide the students with a comprehensive understanding of Electric drives and its control involved in starting, speed regulation, braking, and reversal. It also aims to provide the students with an understanding of the application of power electronic converters for controlling the electric drives

COURSE OUTCOMES: After the completion of the course, student will be able to

CO1	Demonstrate the knowledge of particular type of AC/DC drives.
CO2	Use the knowledge for the analysis the DC drive system.
CO3	Analyze the AC drive systems.
CO4	Effectively apply the knowledge of drives for closed-loop systems.
CO5	Analyze applications of solar powered drives and traction drives.

UNIT-I: Introduction, concept of electric drives classification and components, characteristic, starting, speed control and braking of electric motors (dc and ac), Electro-mechanical transients during starting and braking, time energy calculation, load equalization.

UNIT-II: Converters for feeding electric motors – line commutated converters, choppers, inverters,cycloconverters, ac voltage controllers.

UNIT III: Induction motor drive system, scalar control, vector control, sensor less control.

UNIT-IV: Permanent magnet motor drive system, number of phases, radial and axial field, closed loop control, sensor elimination and reduction, Energy conservation in Electric drives. Switched Reluctance Motor Drive Systems.

UNIT-V: Solar and battery powered drives Solar powered pumps, Traction drives, mainline and suburban train configurations, Application of polyphase ac motors in traction drives

TEXTBOOKS:

[T1] G K Dubey, Power Semiconductor Controlled Drives, Prentice Hall Englewood Cliffs, New Jersey.

REFERENCE BOOKS:

[R1] S. K. Pillai, A First Course in Electric Drives, New Age Publications, New Delhi.
[R2] P C Sen, Principles of Electric Machines and Power Electronics, John Wiley.
[R3] M. H. Rashid, “Introduction to Power Electronics”, Pearson Education India, New Delhi.
[R4] G. K. Dubey, Fundamentals of Electric Drives, Narosa Publications, New Delhi.

WEB RESOURCE :

[W1] https://archive.nptel.ac.in/courses/108/104/108104140/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Industrial Drives	Dr. K .R. Rajagopal	IIT Delhi
2.	Advanced Electric Drives	Dr. S.P. Das	IIT Kanpur
3.	Fundamentals of Electric Drives	Prof. Shyama Prasad Das	IIT Kanpur
4.	Industrial Drives - Power Electronics	Prof. K. Gopakumar	IISc Bangalore

EEE-706: VLSI DESIGN

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Analog Electronics, Digital Electronic etc.

COURSE OBJECTIVES&COURSE DESCRIPTION: The students will be exposed to basic concepts in digital integrated circuit design and some widely used digital subsystems. The students will be exposed to basic concepts in analog integrated circuit design and some widely used analog subsystems.

COURSE OUTCOMES: After the completion of the course, the students will be able to:

CO1	Understand IC processing steps
CO2	Understand IC process integration
CO3	Design basic CMOS digital circuits.
CO4	Design basic CMOS analog circuits.
CO5	Draw and design the CMOS compatible layouts of the above circuits.

UNIT-I: Introduction to NMOS, PMOS and CMOS, IC Processing Steps: Mask Making and Pattern Generation; Mask and Printing Defects; Yield; Basic Processing Steps of IC Fabrication; Lithography; Wet and Dry Etching; Oxidation, Diffusion, Ion Implantation; Annealing, Epitaxial Growth, CVD, Metallization.

UNIT-II: IC Process Integration: Self Alignment; Isolations: Junction Isolation; Guard-Ring; Shallow and Deep Trench; Local Oxidation; CMOS Technology: High-k Processes, Bipolar Technology, BiCMOS Technology; Introduction to SOI, SiGe and GaAs.

UNIT III: CMOS Digital Design: Integrated Circuit Layout and Design Rules; Layout of a CMOS Inverter, NAND and NOR Gates; Design and Performance Optimization of Static CMOS Gates Using Logical Effort.

UNIT-IV: CMOS Analog Design: Design Flow of Analog Circuits; CMOS Amplifier Topologies: Common Source, Common Gate, Common Drain; Parameter Optimization; Layout of a CMOS Amplifier; Overview of Radio Frequency Circuits.

UNIT-V: Design for testability, Packaging technology, I/O issues: ESD protection, boundary scan, inductance, synchronization. Design of Differential Amplifiers, Operational Amplifiers, Stability and Frequency Response.

TEXTBOOKS:

[T1] J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits : A Design Perspective, Pearson
[T2] Razavi, Design of Analog CMOS Integrated Circuits, Mc GRAW-Hill
[T3] Jan M. Rabaey, Anantha P. Chandrakasan, BorivojeNikolić, Digital Integrated Circuits, 2/e, Pearson Education, 2003.

REFERENCE BOOKS:

[R1] W.Wolf, Modern VLSI Design: Systems-on-Chip Design, Pearson
[R2] P. Uyemura, Introduction to VLSI Circuits and Systems, Wiley

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	VLSI Design	Prof. A. N. Chandorkar	IIT Bombay
2.	VLSI Technology	Dr. N. Dasgupta	IIT Madras

EEE-707: BIOMEDICAL INSTRUMENTATION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Tutorial, etc.

Pre requisites: Basic knowledge of Electrical and Electronics Engineering

COURSE OBJECTIVES & COURSE DESCRIPTION: The course is designed to equip students with a comprehensive knowledge of instrumentation used in healthcare and medical diagnostics. The syllabus covers various aspects, including the fundamentals of sensors and transducers, the recording and analysis of biomedical signals (such as ECG and EEG), the design of medical instruments (including stimulators and diagnostic devices), and an exploration of medical imaging techniques. Students will gain practical insights into sensor technology, medical signal processing, and medical imaging applications. This course prepares students for careers in the field of biomedical engineering and healthcare technology, allowing them to contribute to advancements in medical diagnostics and patient care.

COURSE OUTCOMES: After successfully completing the course:

CO1	Student is able to gain the knowledge of Types of biomedical amplifiers and Source of biomedical signals and electrodes.
CO2	Student is able to gain the knowledge of active and passive sensors sensor terminologies.
CO3	Student is able to gain the knowledge of ECG, its waveform, determination of heart rate, EEG.
CO4	Student is able to gain the knowledge of various types of stimulators.
CO5	Student is able to gain the knowledge of medical imaging technologies.

UNIT-I: Electrical activities of cell, body fluids, body as a control system, biomedical signals and electrodes, biomedical amplifiers, general block diagram of biomedical instrumentation.

UNIT-II: Active versus passive sensors, Sensor error sources, sensor terminology, electrochemical sensors, electrodes for biophysical sensing, transducer and transduction principles, active and passive transducers, transducers for biomedical applications, transducer care.

UNIT III: Electrical activities of Heart, ECG waveform, Frontal plane ECG measurements, Lead systems for ECG recording, determination of heart rate, electrocardiograph, ECG faults and troubleshooting, Introduction of EEG based instruments.

UNIT-IV: Stimulators; types of stimulators, electro-diagnostic/ therapeutic stimulator, peripheral nerve stimulator, AC and DC defibrillators, pacemakers, diathermy, respirators, blood pumps, Myoelectric control of paralyzed muscles.

UNIT-V: Electrical impedance plethysmography (EIP), Audiometry, X-rays and radiography, X-ray computed tomography, diagnostic ultrasound, electromagnetic flow meter, Magnetic resonance imaging, applications of EIP in aerospace medicine.

TEXTBOOKS:

[T1] Joseph J. Carr and John M. Brown. Introduction of Biomedical Equipment Technology. 4th Edition, Pearson Education Asia, 2001
[T2] John G. Webster. Medical Instrumentation Application and Design. 5th Edition, John Wiley & sons, 2020.

REFERENCE BOOKS:

[R1] Raja Rao, C; Guha, S.K. Principles of Medical Electronics and Biomedical Instrumentation. Universities Press (India) Limited 2013.
[R2] Barbara Christe. Introduction to Biomedical Instrumentation: The Technology of Patient Care. Cambridge University Press, 2012.
[R3] John E, Susan B, Joseph B. Introduction to Biomedical Engineering. 2nd Edition, Academic Press, Indian Reprint 2009.

EEE-708: ELECTRICAL MACHINE DESIGN

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	PEC	42

Pedagogy: Classrooms lecture, Case studies, Group discussion, Seminar etc.

Course Objectives & Course Description:
This course aims to develop knowledge on principles of design of electrical machines of given specifications.

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COURSE OUTCOMES: After the completion of the course, students will be able to:

CO1	Comprehend basic principle of electrical machines design.
CO2	Design the transformers of different types.
CO3	Designate the number of turns in the windings, current density, conductor section, finding the window area, window space factor, overall dimensions of core
CO4	Evaluate the performance of the transformer by having understanding of different losses, efficiency and voltage regulation of the transformer..
CO5	Comprehend basic principle of rotating machines design.

UNIT-I: Machine design basic principles, limitations in the design of electrical machines, magnetic circuit design, Heating and cooling of electrical machines.

UNIT-II: Transformer Design, Core dimensions and winding turns- emf equation, output equation, iron and coppper cost. Magnetizing current- calculations. Reactance- design and calculations. Cooling design- heat dissipation, plain tank, cooling tubes, methods of cooling. Construction and fitting details design- core binding, coil assembly, terminal gear, tank construction, fittings, bushings, cable box, conservator, indicators, breather, explosion vent, pressure release relay, tap changers, valves, buchhoz relay, lugs, oil cooling equipment, rollers, earthing terminals, rating and diagram plates.

UNIT III: Design considerations for oil cooled transformers- RFC specifications, DGTD regulations, loss capitalization, winding details, conductor charts, core data, design procedure, volts/turn, core area, core circle, core steps, LV and HV windings, clearance and insulation details, weight of conductors and core, tank dimensions, cooling calculations, oil calculation, design calculations, types of windings.
.
UNIT-IV: Losses, percentage impedance, voltage regulation, efficiency of the transformer and their calculations.

UNIT-V: Introduction to rotating machines design, types of winding in rotating machines, winding design, slot design calculations, introduction to new softwares for electrical machine design.

TEXTBOOKS:

[T1] A K Sawhney, Design of Electrical Machines, Dhanpat Rai & Co. 2014.
[T2] M.G. Say, "Performance and Design of A.C. Machines", CBS Publishers

REFERENCE BOOKS:

[R1] Balbir Singh, Electrical Machine Design, Vikas Publishing House, New Delhi.
[R2] P. Pyrhönen, Juha; Jokinen, Tapani; Hrabovcová, Valéria. Design of rotating electrical machines. Chichester: John Wiley & Sons, 2008.
[R3] Hamdi, Essam S. Design of small electrical machines. Chichester [etc.]: John Wiley & Sons, cop. 1994.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Computer-Aided Design of Electrical Machines	Prof. Bhim Singh	IIT Delhi
2.	Design of Electric Motors, IISc Bangalore	Prof. Prathap Reddy	IISc. Bangalore

EEO-701: ADVANCE POWER ELECTRONICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Pre requisites: Power Electronics

COURSE OBJECTIVES & COURSE DESCRIPTION: The course typically aims to provide students with an advanced knowledge of power electronics and its application in various fields such as renewable energy, electric vehicles, smart grid, smart cities etc.

COURSE OUTCOMES: After successfully completing the course,

CO1	Students will be able to have the background knowledge of power electronics basics.
CO2	Students will have the knowledge of advance application of power electronics in renewable energy
CO3	Students will be able design power electronics circuits for Electric vehicles
CO4	Students will be capable for designing of power electronics circuits for other advance applications like smart grid etc.
CO5	Students will be able to model the power electronics converters and perform its stability analysis.

UNIT-I:

Review of Power Electronics converters: AC-DC,DC-AC,DC-DC, AC-AC converters, Devices: Its operation and Control, PWM Techniques

UNIT-II:

Application of Power Electronics in Renewable energy: Solar PV, Wind , Fuel Cell, MPPT Techniques, Grid Synchronization, Grid Codes, Active & Reactive Power Control to/from grid.

UNIT III:

Application of Power electronics for Electric Vehicles: Charging Station infrastructure, Chargers, EV configuration, EV Power management, G to V, V to G concept. Battery terminologies.

UNIT-IV

Application of Power Electronics in Artificial lighting, UPS, Home appliances, Microgrid, Traction, space aircrafts, Smart Grid, Smart cities

UNIT-V:

Modelling and control of Power Electronics Converter, Small signal stability analysis, Generic model of grid connected inverters, Average model of grid connected inverters.

TEXTBOOKS:

[T1] M. H. Rashid, “Introduction to Power Electronics- Circuits, devices and application”, Pearson Education India, New Delhi.

[T2] A Haque, M A Khan, K V S Bharath, “Design and Control of Grid connected PV System” CRC Press, USA.

REFERENCE BOOKS:

[R1] P. C. Sen, “Power Electronics” Tata McGraw Hill Book Co., New Delhi.

[R2] G. K. Dubey, S.R. Doradla, A.Joshi and R.M.K. Sinha, “Thyristorised Power Controllers” Wiley Eastern Ltd., New Delhi.

WEB RESOURCE :

[W1] www.nptel.ac.in

EEO-705: CYBER PHYSICAL SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Pre requisites: Programming Languages , Data Structures and Algorithms

COURSE OBJECTIVES & COURSE DESCRIPTION: The course introduces the core concepts, principles, and real-world applications of Cyber-Physical Systems. It provides a deep understanding of CPS hardware and software platforms, including processors, sensors, actuators etc. It develops skills in students in designing and analyzing control systems for CPS, focusing on stability analysis, dynamical systems, controller design.

COURSE OUTCOMES: After successfully completing the course, the students will be able to

CO1	Explain the principles and real-world applications of cyber physical systems
CO2	Design and evaluate cyber physical systems hardware and software platforms
CO3	Apply control design techniques to cyber physical systems
CO4	Implement intelligent algorithms for cyber physical systems applications
CO5	Securely deploy cyber physical systems and identify potential vulnerabilities and assess cyber physical systems performance in real-world scenarios

UNIT-I: CYBER PHYSICAL SYSTEMS

Cyber-Physical Systems (CPS) in the real world - Basic principles of design and validation of CPS - models of physical process, finite state machines, computation, converters between physical and cyber variables, and digital networks - Industry 4.0 – Auto SAR - IIOT implications - Building Automation - Medical CPS

UNIT-II: CPS - PLATFORM COMPONENTS

CPS HW platforms - Processors, Sensors, Actuators - mCPS Network – Wireless Hart, CAN, Automotive Ethernet - CPS Sw stack - RTOS - Scheduling Real Time control tasks

UNIT III: PRINCIPLES OF AUTOMATED CONTROL DESIGN

Dynamical Systems and Stability - Controller Design Techniques - Stability Analysis: CLFs, MLFs, stability under slow switching - Performance under Packet drop and Noise - Tutorial: Matlab toolboxes - Simulink, State flow Features to software components - Mapping software components to ECUs - CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion.

UNIT-IV: INTELLIGENT CPS

Safe Reinforcement Learning - Robot motion control - Autonomous Vehicle control – Gaussian Process Learning - Smart Grid Demand Response - Building Automation

UNIT-V: SECURE DEPLOYMENT OF CPS& APPLICATIONS OF CPS

Secure Task mapping and Partitioning - State estimation for attack detection – Automotive Case study : Vehicle ABS hacking - Power Distribution Case study : Attacks on Smart Grids – Virtual Instrumentation – Applications of CPS..

TEXTBOOKS:

[T1] Robert H. Bishop, Introduction to Cyber-Physical Systems, Pearson.

REFERENCE BOOKS/REFERENCES:

[R1] E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.
[R2] R. Alur, "Principles of Cyber-Physical Systems," MIT Press, 2015.
[R3] T. D. Lewis "Network Science: Theory and Applications", Wiley, 2009.
[R4] P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer Verlag 2009.
[R5] C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
[R6] Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996.
.

WEB RESOURCE :

[W1] www.nptel.ac.in

EEP-701: SUMMER INTERNSHIP

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	PROJ

To get the hands-on training and get familiarization with the industrial working environment, students will undergo one month Summer Internship program during summer vacation. In this program, students are supposed to get professional training from relevant Industries such as power transmission and distribution sites, power plants, software companies, automobile industry etc. The recommendation letter for this will be given by the Placement Coordinator of the Department or the Training and Placement office of the Faculty of Engineering and Technology. On successful completion of one month training, students will be required to submit a 15-20 pages report of their training program duly certified by the company/industry. Every student has to give the power point presentation of about 15 minutes duration of their training before the duly constituted committee of Faculty Members of the department for the assessment as a part of Mid Term Evaluation

EEP-702: MINOR PROJECT

L	T	P	Credit	Assessment:	Type of Course
0	0	6	3	Mid Sem.60%+ End Sem.40% =100%	PROJ

This is generally a preparation to the major project and may involve literature review, preparatory training on software and hardware, and preliminary experimentation. During the project period, every student has to give the power point presentation of about 15 minutes duration of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EIGHTH SEMESTER COURSES

EEO-801: HIGH VOLTAGE ENGINEERING

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Switchgear & Protection

COURSE OBJECTIVES & COURSE DESCRIPTION: The objective of the High Voltage Engineering course is to provide students with a comprehensive understanding of the principles, technologies, and practices involved in the generation, transmission, and utilization of high voltages in electrical systems.

COURSE OUTCOMES: After successfully completing the course,

CO1	The students will be able to understand the fundamental concepts of high voltage engineering.
CO2	The students will be able to understand the various techniques used for generating and measuring high voltages
CO3	The students will be able familiarized the various insulation materials and their properties.
CO4	The students will be able to understand the testing techniques of various high voltage equipments.
CO5	The students will be able to familiarize with high voltage safety standards, measures and precautions.

UNIT-I: Introduction to high voltage engineering: Definition and significance of high voltage engineering, Applications of high voltages, Challenges and safety considerations, Electrostatic Field Theory, Electrostatic Stress Control Techniques, Conductor Systems.

UNIT-II: Generation of High Voltages: Generation of High DC, AC and Impulse Voltages, High Voltage Testing of Electrical Apparatus, Measurement of High Voltages and High Currents, Digital Techniques in High Voltage Measurements.

UNIT III: Insulation Materials and their Properties: Solid, Liquid, and Gas Insulating Materials, Properties of Insulating Materials, Breakdown in Gases, Liquids, and Solids, Partial Discharge Measurement, Ageing of Insulating Materials

UNIT-IV: Introduction to High Voltage Testing of Power Equipment**,** Testing of Cables, Transformers, Circuit Breakers, Insulators, etc.

UNIT-V: Non-destructive Testing Techniques, High Voltage Testing Standards and Practices, Safety Measures in High Voltage Testing

TEXTBOOKS:

[T1] M. S. Naidu and V. Kamaraju, “High Voltage Engineering", second edition, McGraw-Hill.

REFERENCE BOOKS:

[R1] C. L. Wadhwa , “High Voltage Engineering", New Age International Publishers, New Delhi.
[R2] E. Kuffel, W. S. Zaengl, and J. Kuffel , “High Voltage Engineering Fundamentals", Newnes.

WEB RESOURCE :

[W1] https://archive.nptel.ac.in/courses/108/104/108104048/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	High Voltage Engineering	Prof. Ravindra Arora	IIT Kanpur

EEO-802: GRID PROTECTION AND CONTROL

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classroom instruction will consist of interactive lectures, class discussions, PowerPoint presentations, and video illustrations.

Pre requisites: Basic understanding of Power System and Power Electronics Engineering.

COURSE OBJECTIVES & COURSE DESCRIPTION: The characteristics and behaviour of power systems changes when the share of variable energy increase in the total mix. With the increase in penetration from renewable energy sources, the dynamics of the existing electricity infrastructure must be understood. This course provides a platform for strong understanding related to the phenomenon of integrating renewable energy sources. The course is focussed on causes, effects and recovery measures when power from renewable energy sources are injected to the grid.

COURSE OUTCOMES: After successfully completing the course, the students will be able:

CO1	To learn about recent trends in grids as smart grid
CO2	To understand about smart grid architecture and technologies
CO3	To know about smart substations
CO4	To learn about smart transmission systems
CO5	To learn about smart distribution systems

UNIT-I: Working definitions of Smart Grid and Associated Concepts:
Smart Grid Functions —Traditional Power Grid and Smart Grid, New Technologies for Smart Grid advantages, Indian Smart Grid, Key Challenges for Smart Grid, Smart Grid Architecture: Components and Architecture of Smart Grid Design —Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs — Transmission, Automation, Distribution Automation — Renewable Integration

UNIT -II: Smart grid Technologies:
Characteristics of Smart grid, Micro grids, Definitions, Drives, benefits, types of Micro grid, building blocks, Renewable energy resources, needs in smart grid, integration impact, integration standards, Load frequency control, reactive power control, case studies and test beds

UNIT -III: Protection, Monitoring and control devices, sensors, SCADA, Master stations, Remote terminal unit, interoperability and IEC 61850, Process level, Bay level, Station level, Benefits, role of substations in smart grid, Volt/VAR control equipment inside substation.

UNIT -IV: Energy Management systems, History, current technology, EMS for the smart grid, Wide Area Monitoring Systems (WAMS), protection & Control (WAMPC), needs in smart grid, Role of WAMPC smart grid, Drivers and benefits, Role of transmission systems in smart grid, Synchro Phasor Measurement Units (PMUs).

UNIT -V: DMS, DSCADA, trends in DSCADA and control, current and advanced DMSs, Voltage fluctuations, effect of voltage on customer load, Drivers, objectives and benefits, voltage- VAR control, VAR control equipment on distribution feeders, implementation and optimization, FDIR - Fault Detection Isolation and Service restoration (FDIR), faults, objectives and benefits, equipment, implementation

TEXT BOOKS:

[T1] Stuart Borlase, Smart Grids - Infrastructure, Technology and Solutions, CRC Press, e,2013

[T2] Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2e,2013.

REFERENCE BOOKS:

[R1] A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition, 2e, 2017.

[R2] T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2e,2012.

EEO-803: MECHTRONICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classroom instruction will consist of interactive lectures, class discussions, PowerPoint presentations, and video illustrations.

Pre requisites:.Control Systems, Introduction to Robotics

COURSE OBJECTIVES & COURSE DESCRIPTION: The primary objective of this course is to provide students with an interdisciplinary understanding of the integration of mechanical, electrical, and computer engineering. The course will focus on systems design, control, automation, and the role of sensors, actuators, and microcontrollers in the development of intelligent machines. Students will learn the principles of mechatronics and how to apply them to real-world engineering problems.

COURSE OUTCOMES: After successfully completing the course, the students will be able to

CO1	Understand and apply mechatronic system design principles integrating mechanical, electrical, and software components.
CO2	Analyze and model mechatronic systems for real-time applications in automation and robotics.
CO3	Design and implement control systems using sensors and actuators, applying concepts of control theory.
CO4	Develop embedded systems for mechatronics applications using microcontrollers, programming, and hardware interfacing
CO5	Evaluate and test mechatronic systems through practical, hands-on projects and experiments.

UNIT-I: Introduction to Mechatronics Systems:
Definition and scope of mechatronics, History and evolution of mechatronics, Elements of mechatronic systems: Mechanical, electrical, computer, control, and sensor subsystems, System approach and interdisciplinary nature of mechatronics, Applications of mechatronics in industry (e.g., manufacturing, robotics, automotive systems, and consumer products)

UNIT -II: Sensors and Actuators:
Types of sensors: Displacement, temperature, force, pressure, proximity, and optical sensors, Sensor characteristics: Accuracy, sensitivity, resolution, and range, Types of actuators: Electric motors, hydraulic and pneumatic actuators, piezoelectric actuators, Signal conditioning and interfacing sensors and actuators with microcontrollers, Practical applications of sensors and actuators in mechatronics systems

UNIT -III: Microcontrollers and Embedded Systems
Introduction to microcontrollers and embedded systems, Architecture and working of microcontrollers (e.g., 8051, PIC, Arduino), Programming of microcontrollers (e.g., C, Embedded C), Interfacing with sensors and actuators through microcontrollers, Practical design of embedded systems for mechatronic applications.

UNIT -IV: Control Systems in Mechatronics
Introduction to control systems and their role in mechatronics, Feedback control and its importance in mechatronic systems, PID controllers and their implementation in mechatronics, Modeling of mechatronic systems (mathematical modeling and block diagrams), Stability analysis and performance measures for control systems in mechatronics.

UNIT -V: Mechatronics System Design and Applications
System design process for mechatronics, Integration of mechanical, electrical, and software components into a mechatronic system, Simulation and modeling of mechatronic systems using CAD, MATLAB, and Simulink, Case studies: Industrial automation, robotic arms, CNC machines, autonomous vehicles, Testing and troubleshooting mechatronic systems

TEXT BOOKS:

1. Clarence W. de Silva, “Mechatronics: A Foundation Course", CRC Press, 1st Edition, 2009Gil Masters,
2. David G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement Systems" , McGraw-Hill Education, 4th Edition, 2010.

REFERENCE BOOKS:

1. William Bolton, Mechatronics: Principles and Applications", Pearson, 4th Edition, 2015.
2. W. L. Berry et al , "Mechatronics and Automation", CRC Press, 1st Edition, 2017.
3. Godfrey C. Onwubolu, "Mechatronics: Principles and Applications", Elsevier, 1st Edition, 2005.

EEO-804: SOFT COMPUTING

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Set Theory

COURSE OBJECTIVES&COURSE DESCRIPTION: Soft computing is an emerging approach to computing which emulates the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision. Soft computing is based on some biological inspired methodologies such as genetics, evolution, particles swarming, human nervous systems, etc. This course will cover fundamental concepts used in Soft Computing. The concepts of Fuzzy logic (FL) will be covered first, followed by Artificial Neural Networks (ANNs) and optimization techniques using Genetic Algorithm (GA). Applications of Soft Computing techniques to solve a number of real life problems will be covered.

COURSE OUTCOMES: After successfully completing the course, the students will be able to:

CO1	Learn about difference between hard computing and soft computing techniques, and applications of soft computing, basics of fuzzy system
CO2	Understand and implement fuzzy inference systemfor problems of power system domain.
CO3	Learn the basics of ANN and various learning algorithms.
CO4	Understand and analyze various ANN architecture and hybrid systems and apply to various problems
CO5	Understand Genetic Algorithm and their applications

UNIT-I: Hard Computing: Features of Hard Computing, Soft Computing: features of soft computing, Hybrid Computing, Fuzzy Set Theory: fuzzy versus crisp sets, basic fuzzy set operations, linguistic variables, membership functions, fuzzy Cartesian product, fuzzy relations, fuzzy rules.

UNIT-II: Approximate reasoning, fuzzy modelling, fuzzification, inferencing and defuzzification, fuzzymodeling and control schemes for nonlinear systems, Fuzzy logic controller design, applications in power system.

UNIT III: Biological neural networks, models of an artificial neuron, neural network architectures, characteristics of neural networks, McCulloch-Pitts neuron, learning methods, Hebbian learning rules, Hebb nets.

UNIT-IV: Architecture of back propagation networks, perceptron model, single layer and multi-layer perceptron models, back propagation learning, tuning parameters of back propagation networks, Training techniques for ANNs, neuro-fuzzy models, adaptive neuro-fuzzy inference system (ANFIS), applications

UNIT-V: Basic concepts, creation of off springs, working principle, encoding, fitness function, reproduction, Genetic Modelling; inheritance operators, cross over, inversion and deletion, mutation operator, bit-wise operator, generational cycle, convergence of genetic algorithm, multi-level optimization, real life problems.

TEXTBOOKS:

[T1] Soft Computing and Intelligent System Design: Theory, Tools and Applications, Fakhreddine O. Karray and Clarence De Silva, Pearson Education Ltd., India.
[T2] Soft Computing: Techniques and its Applications in Electrical engineering, Samir Roy Chakorborty, Springer-Verlag, Germany.
[T3] Soft Computing and its Applications, R. A. Aliev and R. R. Aliev, World Scientific Publishing Co. Pte. Ltd., Singapore.
[T4] Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, J.-S. R. Jang, C.-T. Sun, and E. Mizutani, Pearson Education Ltd., India.
[T5] Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, S.Rajasekaran and G. A. VijayalakshmiPai, Prentice Hall of India, New Delhi.
[T6] Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.

REFERENCE BOOKS:

[R1] Fuzzy Logic: A Pratical approach, F. Martin, , Mcneill, and Ellen Thro, AP Professional
[R2] Neural Networks and Learning Machines, (3rd Edn.), Simon Haykin, PHI Learning, 2011.
[R3] An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, 2000.

WEB RESOURCE:

[W1] https://www.udemy.com/course/fuzzylogic
[W2] https://www.mooc-list.com/tags/fuzzy-logic
[W3] https://www.mygreatlearning.com/academy/learn-for-free/courses/introduction-to-neural-networks-and-deep-learning
[W4] https://www.udemy.com/course/genetic-algorithms-in-python-and-matlab/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Introduction to Soft Computing	Prof. Debasis Samanta	IIT Kharagpur
2.	Fuzzy Logic & Neural Network	Prof. Dilip Kumar Pratihar	IIT Kharagpur

EEO-805: ELECTRICITY MARKETS AND REGULATION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Power Generation, SCADA System, Smart Grid, Electrical Power System

COURSE OBJECTIVES & COURSE DESCRIPTION: This subject course objective is to introduce students about the regulation and re-structuring of power system since the high level of penetration of distributed power generation in the grid and emerging power market across the world.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Know the basic understading about need of restructuring of power system
CO2	Understand the deregulated Gencos, Discoms and Transcos
CO3	Know and understand about emerging electricity market
CO4	Understand the transmission congestion and congestion management.
CO5	Understand the power exchange and open access strategies.

UNIT-I: Power System Restructuring: An overview of the restructured power system, Reforms in Indian power sector, framework of Indian power sector. Basic concept and definitions: privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system; advantages of competitive system.

UNIT-II: Reform Motivation, Seperation of ownership and operation, Independent System Operators (ISOs), GENCO, DISCO and TRANSCO.

UNIT III: Evolution of electricity markets, wholesale electricity market, philosophy of market models, comparison of various market models, electricity vis e vis other markets, Market Architecture. Consumer behaviour, Market equilibrium. Local marginal prices.

UNIT-IV: Transmission and congestion management, nodal pricing, inter-zonal and intra-zonal congestion management, price area congestion management, capacity alleviation methods. Total Transfer Capability (TTC), Available Transfer Capability (ATC), Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.

UNIT-V: Power Exchange and ISO: functions and responsibilities, Indian scenario for exchange of power, scheduling coordinators, open access coordination strategies.

TEXTBOOKS:

[T1] Loi, Lei lai, "Power system restructuring and deregulation, trading performance and Information technology, John Wiley & Sons limited [TB]
[T2] K. Bhattacharya, M. H. J. Bollen and J. E. Daalder, "Operation of Restructured Power Systems", Springer.

REFERENCE BOOKS:

[R1] L. Philipson and H L. Willis, "Understanding Electric Utilities and Deregulation", CRC Press.
[R2] M. Shahidehpour, H. Yamin and Z. Li, "Market Operations in Electric Power Systems", John Wiley.
[R3]. N. S. Rau, "Optimization Principles: Practical Applications to the Operation and Markets of the Electric Power Industry", John Wiley.

WEB RESOURCE :

[W1] https://nptel.ac.in/courses/108101005

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Restructured Power System	Prof. S.A. Khaparde, Dr A.R. Abhyankar	IIT Delhi

Computer Usage / Software required: Simulink / Matlab

EEP-801: MAJOR PROJECT

L	T	P	Credit	Assessment:	Type of Course
0	0	12	6	Mid Sem.60%+ End Sem.40% =100%	PROJ

The objective of the major project is to develop and enhance students' analytical and problem tackling skills. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers. The project may be analytical, computational and experimental or combination of them. It should consist of objectives of study, scope of work, critical literature review and an extension of Minor Project. During the project period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

HONOURS DEGREE SPECILIZATION COURSES
(1. CONTROL & AUTOMATION)

EEH-411: SPECIAL ELECTRICAL MACHINES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: DC Machines, Synchronous Machines and Induction Machines.

COURSE OBJECTIVES & COURSE DESCRIPTION: This subject course objective is to introduce students about the core concepts, explanation of different phenomenon and governing equations related to Special Machines. This course along with Electrical machines develops a comprehensive understanding of special machines.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Describe construction, working principle and characteristics of Switched Reluctance Motor (SRM).
CO2	Understand the open loop and closed loop systems for Servo Motors and Stepper Motors.
CO3	Analyze the torque speed characteristics and transfer function of Permanents Magnet Synchronous Motors (PMSM).
CO4	Describe construction, working principle and characteristics of Permanents Magnet Brush less DC (BLDC) Motor.
CO5	Understand the dynamic characteristics, drive system, open loop systems for Linear motors.

UNIT-I: SWITCHED RELUCTANCE MOTORS (SRM): Introduction, Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques and Drive – Concept, Mathematical model and analysis.

UNIT-II: SERVOMOTORS & STEPPER MOTORS: Introduction, Constructional features, Principle of operation, Modes of excitation, Torque production in Variable Reluctance (VR) motor, dynamic characteristics, Drive system and circuit for open loop control, closed loop control, Stability and areas of applications.

UNIT III: PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM): Introduction, Permanent magnet materials and motors, Principle of operation, EMF and torque equation, Torque speed characteristics,Power Controllers, Comparisons of conventional and PM synchronous motor, Transfer function of PMSM and control Schemes of PMSM.

UNIT-IV: PERMANENT MAGNET BRUSHLESS DC (BLDC) MOTORS: Introduction, Constructional features, Principle of operation, Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Types of BLDC motors, EMF and torque equation, Torque-speed characteristics, Drives - concept and Control of BLDC motors.

UNIT-V: LINEAR MOTOR:Linear Induction Motor (LIM), Construction features, Principle of operation, Thrust equation, Concept of Current sheet, Goodness factor, Equivalent circuit, Performance characteristics, Control strategies. Linear Synchronous Motors (LSM) Construction features, Principle of operation, Thrust equation, Control strategies, Applications. Linear Levitation Machines (LLM), Principle of operation, Attraction and repulsion types of LLM, Goodness factor and Levitation stiffness. Introduction to IoT based machine control system.

TEXTBOOKS:

[T1] K. Venkataratnam, "Special Electrical Machines", Universities Press (India) Private Limited, Hyderabad, First Edition reprinted in 2013.
[T2] E.G. Janardanan, "Special Electrical Machines", PHI Learning Private Limited, Delhi First Edition reprinted in 2014.

REFERENCE BOOKS:

[R1] R. S. Krishnan, "Switched Reluctance Motor Drives: Modeling Simulation Analysis, Design and Application" CRC press2001.
[R2] Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
[R3] R.S.Krishnan, "Permanent Magnet Synchronous Motor and Brushless DC Motor Drives",RC press,2002.
[R4] NaserA and Boldea I, "Linear Electric Motors: Theory, Design and Practical Application",Prentice Hall Inc., New Jersey, 1987.
[R5] Kenjo T, " Stepping Motor and their Microprocessor control", Clarendon press Oxford,1989

WEB RESOURCE :

[W1] http://nptel.ac.in/courses/electricalmachines

Computer Usage / Software required: Simulink / Matlab

EEH-511: ELECTRIC VEHICLE & ENERGY MANAGEMENT SYSTEM (EMS)

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Pre requisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: The course objectives for a course on "Electric Vehicle and Energy Management System" aims to provide students with a strong foundation in the principles, technologies, and practical applications of electric vehicle (EV) and related Energy Management System. This includes the basic to advance knowledge of EV and EMS requirements and design.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain basics of electric vehicle and its architecture.
CO2	Analyze the fundamentals of power electronics and control technology for EVs
CO3	Apply the knowledge todesign the EV charging infrastructure
CO4	Understand the Energy Management system for EV along with basics of optimization techniques
CO5	Discuss advance topics like BMS, Reliability of EV converters.

UNIT-I: History and evolution of Electric vehicles. Overview of Electric Vehicles and their types. Environmental and economic considerations. Electric Vehicle Architecture and components. Government policies and Industry specifications. Market trends.

UNIT-II: Power Electronics and control systems for charging of EVs (Battery, Battery with Supercapacitors etc). Charging cables and connectors, Safety standards and protocols. Charging station design and installation -A case study. Battery Management System, Power Electronics for EC drive.

UNIT III: Electric Vehicle charging infrastructure: Types of EV chargers (Level 1, Level 2, DC Fast Chargers), Charging standards (ChadeMo, CCS, Tesla supercharges) , Charging infrastructure deployment and challenges, Smart Charging and Vehicle to Grid, Grid to vehicle charging concepts. Wireless charging

UNIT-IV: Introduction to Energy Management System (EMS), Energy Optimization Techniques, Vehicle to Grid, Grid to Vehicle, Vehicle to home concept. EMS with in EV.

UNIT-V: Battery state of charge and state of health monitoring, thermal management in EVs, Reliability analysis of EV converters (with Advance techniques – Image Processing, AI etc). Autonomous EV, Future trend of EV. Industry solutions for reliability of EVs/Battery, Smart parking with EMS.

TEXTBOOKS:

[T1] Advanced Electric Drive Vehicles Editor: Ali Emadi CRC Press
[T2] Smart Charging Solutions for Hybrid and Electric Vehicles, Sulabh Sachan, P. Sanjeevi Kumar, Sanchari Deb, Wiley Press.

REFERNCEBOOKS:

[R1] Electric Vehicle Integration into Modern Power Network: R Garcia, Springer

WEB RESOURCE :

[W1] www.nptel.ac.in

EEH-611: ROBOTICS AND AUTOMATION

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Should know basic control system

COURSE OBJECTIVES & COURSE DESCRIPTION: The course offers a comprehensive exploration of robotic mechanisms, kinematics, dynamics, and control. Students will gain a deep understanding of fundamental components, kinematic arrangements, and the classification of robots. The curriculum covers trajectory generation, linear feedback control, and two-stage control, enabling students to design controllers for precise and stable robotic movements. Additionally, the course delves into dynamic equations, inertia tensors, and Newton-Euler formulation for modeling and analyzing robotic system dynamics. Force control techniques, including impedance control and hybrid control, are addressed, providing students with the skills to manipulate and interact with the environment effectively. Overall, the course emphasizes practical applications, ensuring graduates are well-equipped to tackle real-world challenges in the dynamic field of robotics.

COURSE OUTCOMES: After successfully completing the course, students should possess proficiency in

CO1	Robotics encompassing classification, selection criteria, and understanding of industrial robot components and performance characteristics crucial for various applications.
CO2	Sensor selection and understanding of drive types, advantages, and suitability for robotic applications, facilitating optimal sensor and drive integration in robotic systems.
CO3	Manipulator kinematics, including DH transformation, direct and inverse kinematics for industrial robots, and differential kinematics for planar serial robots.
CO4	Controllers, grippers, and mobile robotics, including kinematics and dynamics of various types of robots, facilitating comprehensive expertise in robotics systems.
CO5	Robot applications, programming methods, and languages, along with an understanding of AI's relevance to robotics, ensuring comprehensive expertise in robotic systems.

UNIT-I: Robotics-Introduction-classification with respect to geometrical configuration (Anatomy), Industrial robots specifications. Selection based on the Application. Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics-precession of movement-resolution, accuracy & repeatability-Dynamic characteristics- speed of motion, payload capacity & speed of response, safety measures.

UNIT-II:Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots

UNIT III: Sensors – Characteristics of sensing devices, Criterion for selections of sensors, Classification, & applications of sensors. Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, Grippers and its application, Force or Torque sensors.
Drives – Basic types of drives. Advantages and Disadvantages of each type. Selection / suitability of drives for Robotic application.

UNIT-IV: Controllers: - Types of Controllers and introduction to Close loop controller, Grippers – Mechanical Gripper-Grasping force--mechanisms for actuation, Magnetic gripper vacuum cup gripper-considerations in gripper selection & design.
Introduction to Mobile Robotics - Tasks of mobile robots, robots manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation. Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots. Kinematics and Dynamics of Wheeled Mobile Robots (two, three, four - wheeled robots, omni-directional and macanum wheeled robots).

UNIT-V: Robot Applications: Material transfer and machine loading/unloading, processing operations assembly and inspection. Concepts of safety in robotics, social factors in use of robots, economics of robots.

Programming and Languages: - Methods of robot programming, Introduction to various languages such as RAIL and VAL II, Features of each type and development of languages for recent robot systems.

Introduction to AI, relevance of AI with robotics.

TEXTBOOKS:

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005
2. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
4. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
5. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
6. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
7. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt Ltd (2012)
8. R. D. Klafter, Thomas A. Chmielewski, and Mechael Negin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009)
9. Norman S. Nise, "Control System Engineering", 7th Edition, Wiley
10. Richard C Drof, Robert H. Bishop, "Modern Control Systems, Pearson, 13th Edition
11. Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots, The MIT Press, USA, 2011,
12. SG Tzafestas, Introduction to Mobile Robot Control, Elsevier, USA, 2014,
13. A Kelly, Mobile Robotics, Mathematics, Models, and Methods, Cambridge University

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Advanced Robotics	By Prof. Ashish Dutta	IIT Kanpur
2	Robotics: Basics and Selected Advanced Concepts	By Prof. Ashitava Ghosal	IISc Bangalore

Computer Usage / Software required: ROS, Matlab/Simulink

EEL-621: ROBOTICS & AUTOMATION LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	HDC-L

This laboratory course is designed based on theory course of "Robotics & Automation " (EEH-611). There are around 8-10 experiments to be conducted by the students covering almost all units of theory course. The experiments include trajectory tracking and analysis of autonomous mobile robots, obstacle avoidance for autonomous mobile robots, line follower autonomous mobile robots, Interface of BLDC and stepper motor for autonomous robots, pick and place operation for two link manipulator etc.

EEH-711: IoT & TRANSDUCERS TECHNOLOGY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, etc.

Pre requisites:

COURSE OBJECTIVES & COURSE DESCRIPTION: The aim of this course is to provide a thorough understanding of Sensor based Instrumentation systems, Detection electronics and fundamental of IoT.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Understand static and dynamic characteristics of measuring instruments and to develop mathematical model of Instrumentation Systems
CO2	Understand functioning of optical and other type of special transducers.
CO3	Design and implement signal conditioning circuit for different transducers
CO4	Select appropriate sensor and design instrumentations system for industrial applications.
CO5	Design and implement IoT systems.

UNIT-I: General concepts and terminology of measurement systems: Transfer Function, Span (Full-Scale Input), Full-Scale Output, Accuracy, Calibration, Calibration Error, Hysteresis, Nonlinearity, Saturation, Repeatability, Dead Band, Resolution, Excitation. Standards and calibration of measurement Systems, First order instruments: time and frequency response characteristics Second order instruments: time and frequency response characteristics

UNIT-II:Voltage and current transducers, Hall effect transducers, optical transducers, Semiconductor, Piezoelectric, Ultrasonic transducers and their applications. Tactile, Magnetostrictive, Magneto resistive, Electromagnetic and Thermoelectric transducers and their applications.

UNIT III: Design of detection electronics and signal conditioning circuits for various resistive, capacitive, inductive transducers. Active filters, Impedance matching, loading effect. Introduction to electromagnetic interference (EMI), and Radiofrequency interference (RFI), shielding and filtering etc. Concepts of interface with digital devices like PC, µc, µp.

UNIT-IV: Thermal Transducers, LVDT, Strain gauge and their applications. Application of the different traducers for industrial parameters measurement; flow, pressure, rotational speed, liquid level, chemical sensing etc., commercial sensors to measure industrial process parameters, Transducers activated RFID tags.

UNIT-V: IoT Fundamentals, Different IoT Architectures, Design of IoT, Overview of IoT protocols, IoT levels and deployment templates, Challenges for IoT, Interdependencies of IoT and cloud computing, Web of things. Sensors and actuators for IoT applications, IoT components and implementation, Programming of Node MCU and Raspberry PI, Implementation of IoT with Edge devices, Reading sensor data and transmit to cloud, Controlling devices through cloud using mobile application and web application. Broad categories of IoT applications: Consumer IoT, Commercial IoT, Industrial IoT, Infrastructure IoT, Military Things (IoMT)

TEXTBOOKS/REFERENCE BOOK(S) :

1. Curtis D Johnson, Process Control Instrumentation Technology, Eighth Edition, PHI- 2006.
2. Doeblin E.O. Measurement Systems-Application and Design, Fourth Edition, McGraw Hill International Edition, New York-1992.
3. Rahul Dubey, “An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications”, Cengage India Publication.
4. Adeel Javed, “Building Arduino projects for Internet of Things”, A press publication
5. Donald Noris, “The Internet of Things: Do it yourself Projects with Arduino, Raspberry PI and Beagle Bone Black” Mc Graw Hill Publication

EEP-713: PROJECT

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	PROJ

The objective of the project for Honours degree specialization is to develop and enhance students' analytical and problem tackling skills. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers. The project may be analytical, computational and experimental or combination of them based on robotics and control. During the project period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EEH-811: ADVANCED ROBOTICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Control Systems, Robotics and Automation

COURSE OBJECTIVES & COURSE DESCRIPTION: The course offers a comprehensive exploration of advanced topics of robotics. It enables the students to understand Coordinate Systems and Transformations The students will gain the knowledge of Differential Motion and Dynamic Modeling: The students will also develop skills in Trajectory Planning. They will gain knowledge in control strategies for robotic manipulators,

COURSE OUTCOMES: After successfully completing the course, students will be able to

CO1	Solve the composite transformation of coordinate frames and vectors.
CO2	Analyze forward and inverse kinematics equations for various serial and parallel Robots
CO3	Determine the Jacobian matrices and develop dynamic equations for various robots
CO4	Apply joint space and cartesian space trajectory planning for various robots.
CO5	Describe the control systems used in robotics.

UNIT-I: COORDINATE FRAMES, MAPPING AND TRANSFORMATION
Coordinate frames - mapping, mapping between rotated frames, translated frames and both; Description of objects in space; Transformation of vectors- rotation and translation of vectors, combining Rotation and translation of vectors, homogeneous transformation, composite transformation; Euler angle representations. Problems on Transformation of vectors and frames..

UNIT-II: FORWARD AND INVERSE KINEMATICS
Description of links and joints, Denavit-Hartenberg notation, kinematic relationship between adjacent links, manipulator transformation matrix, problems on kinematic modeling of 2 and 3 DoF serial robot configurations; inverse kinematics -manipulator workspace, solvability, multiple solutions, closed form solutions, inverse kinematics problems for 2 and 3 DoF serial robots.

UNIT III: DIFFERENTIAL MOTION AND DYNAMIC MODELING
Linear and angular velocity of a rigid body, combined linear and angular motion, manipulator Jacobian, Jacobian for prismatic and rotary joint, Jacobian singularities, velocity and Jacobian calculations for 2 DoF planar robots.
Lagrangian mechanics, 2 DoF manipulator dynamic model, Lagrange-Euler formulation - generalized coordinates, kinetic energy, potential energy, equations of motion; Newton-Euler formations - linear momentum, angular momentum, equations of motion; comparison of Lagrange-Euler and Newton-Euler formulations; problems for 1 and 2 DoF R-R robots.

UNIT-IV: TRAJECTORY PLANNING
Terminology in trajectory planning, steps in trajectory planning; path planning, skew motion, joint integrated motion; joint space techniques – use of P-degree polynomial as interpolation function, cubic polynomial trajectories; Cartesian space techniques; joint space versus cartesian space trajectory planning, problems on cubic polynomial.

UNIT-V: CONTROLS AND PARALLEL ROBOTS

Control of Manipulators: open and close-loop control, manipulator control problem, linear control schemes–P, D, I, PD, PID, characteristics of second order linear system, linear second order SISO model of a manipulator joint, partitioned PD control scheme, partitioned PID control scheme.

Introduction, types, degrees of freedom for 3 RRR, Spatial 3 RPS and General Stewart-Gough platform, Inverse kinematics of 3 RRR, Spatial 3 RPS and General Stewart-Gough platform.

TEXTBOOKS:

[T1] Mittal RK & Nagrath, “Robotics and Control”, 2nd Edition, TMH, 2008.

[T2] Lung-Wen Tsai, “ Robot Analysis: The Mechanics of Serial and Parallel Manipulators”, John Wiley and sons. Inc. 1999

REFERENCE BOOKS:

[R1] Fu K.S, "Robotics", Mc Graw Hill, 2004.
[R2] Richard D Klafter, "Robotic Engineering", Prentice Hall, 1998.
[R3] Mark W. Spong and M. Vidyasagar, "Robot Dynamics and Control", Johan Wiley & Sons (ASIA) Pvt. Ltd

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Advanced Robotics	By Prof. Ashish Dutta	IIT Kanpur
2	Robotics: Basics and Selected Advanced Concepts	By Prof. Ashitava Ghosal	IISc Bangalore

Computer Usage / Software required: ROS, Matlab/Simulink

HONOURS DEGREE SPECILIZATION COURSES
(2. AI & CYBER SECURITY)

EEH-412: INTRODUCTION TO COMPUTER NETWORKS & CYBER SECURITY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Programming (C/C++, MATLAB, Python, etc.)

COURSE OBJECTIVES&COURSE DESCRIPTION: The objective of this course is to provide introduction to fundamental concepts in the design and implementation of computer networks, their protocols, and applications as well as an insight to information coding techniques, error correction mechanism for cyber security.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Understand the concept of networking foundation.
CO2	Understand the different methods of internetworking.
CO3	Understand the concept of error MAC protocol and Ethernet switches.
CO4	Introduce the principles and applications of information theory.
CO5	Understand the concept of Cyber security and issues and challenges associated with it.

UNIT-I: Networking Foundations: Network elements and architectures, packet and circuit switching, performance measures (delay, throughput), OSI and TCP/IP protocol suites, layering.

UNIT-II: Internetworking: Internet protocol (IP), IP addressing, sub-netting, forwarding, routing algorithms (Dijkstra, Bellman-Ford), distance-vector routing, link-state routing.

UNIT III: Link Layer, LANs, and MAC Protocols: Framing, error detection and correction, multiple access protocols, Aloha, CSMA, Ethernet (IEEE 802.3), Ethernet switches, address resolution protocol (ARP).

UNIT-IV: Shannon's foundation of Information theory, Probability distribution factors, Uncertainty/entropy information measures, Leakage, Quantifying Leakage and Partitions, Lower bounds on key size: secrecy, authentication and secret sharing. Information-theoretic security and cryptograph, basic introduction to Diffie-Hellman, AES, and side-channel attacks.

UNIT-V: Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security. Brief introduction to IT Act, 2000. Role of ICERT, Infrastructure Security, CCMP.

TEXTBOOKS:

[T1] J. Kurose and K. Ross, Computer Networking: A Top-Down Approach (7th edition), Pearson, 2017
[T2] Fundamentals of Network Security by E. Maiwald, McGraw Hill

REFERENCE BOOKS:

[R1] Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.
[R2] Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011).

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Computer Networks	Prof. S. K Ghosh	IIT Kharagpur
2.	Cyber Security	Prof. S. K. Mathew	IIT Madras

EEH-512: INTRODUCTION TO AI & MACHINE LEARNING

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Computer & Programming Fundamentals, Python, C/C++ etc.

COURSE OBJECTIVES&COURSE DESCRIPTION: To review and strengthen important mathematical concepts required for AI & ML. Introduce the concept of learning patterns from data and develop a strong theoretical foundation for understanding state of the art Machine Learning algorithms.

.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain the basics of Artificial Intelligence and techniques. Discuss the mathematical foundation.
CO2	Understand the concepts of knowledge representation and methods in AI
CO3	Design and implement machine learning solutions to classification and regression problems.
CO4	Evaluate and interpret the results of the different ML techniques.
CO5	Design and implement various machine learning algorithms in a range of Real-world applications.

UNIT-I:Introduction to AI, Control strategies, Search strategies, Production system characteristics - Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing, Depth first and Breadth first, Constraint's satisfaction Problem.

UNIT-II: Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, use of predicate calculus, Knowledge representation using other logic: Structured representation of knowledge, First order logic: Syntax and Semantics, Knowledge Engineering in First Order Logic ,Inference in First Order Logic

UNIT III: Introduction to Machine Learning Process, Supervised Learning, Regression, Linear Regression, Predicting, Polynomial Regression, Classification: Feature Engineering, Logistic Regression, kNN classification, SVM, Naive bayes, Decision tree and Random Forest classifier, Unsupervised Learning, Clustering techniques

UNIT-IV:Model representation, decision boundary, cost function, gradient descent, regularization, evaluating a hypothesis (Model selection), training/validation/testing procedures, bias/variance, learning curves, Accuracy and Error measures, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, ROC curve and AUC score, Parameter Tuning.

UNIT-V:Ensemble methods: Ensemble strategies, boosting and bagging; Sequence Models: Hidden Markov Models, Probabilistic Suffix Trees; Applications and Case studies.

TEXTBOOKS:

[T1] Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011.
[T2] Anindita Das Bhattacharjee, "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
[T3] Tom Mitchell, Machine Learning, McGraw Hill, 2017

REFERENCE BOOKS:

[R1] Yuxi (Hayden) Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.
[R2] Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
[R3] T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2011.

WEB RESOURCE:

[W1] https://swayam.gov.in/nd2_cec20_cs10/preview.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Introduction to Artificial Intelligence	Prof. Mausam	IIT Delhi
2.	Introduction to Machine Learning	Prof. S Sarkar	IIT Kharagpur

EEH-612: DEEP LEARNING & ANN

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Computer network, Programming (Python, Java etc.)

COURSE OBJECTIVES&COURSE DESCRIPTION: To strengthen important Mathematical concepts required for Deep learning and neural network.To get a detailed insight of advanced algorithms of ML.

.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain the foundation of the artificial neural network and concept.
CO2	Understand the learning methods of the neural network
CO3	To design and implement CNN.
CO4	To understand RNN.
CO5	Understand the deep unsupervised learning and GAN.

UNIT-I: Information flow in a neural network: Human Brain, Model of an artificial Neuron, Basic concepts of Neural Networks, Fundamentals of Biological Neural Network, understanding basic structure and ANN: Evolution of Neural Networks, Characteristics of Neural Networks.

UNIT-II: Training a Neural network: Learning Methods – supervised, unsupervised and reinforcement, Taxonomy of Neural Network Architectures, Terminologies – weights, bias, threshold, learning rate, Applications of Neural Networks, how to determine hidden layers, recurrent neural network

UNIT III: Basic structure of Convolutional Network, Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, FCNN Case study: Image classification using CNN.

UNIT-IV: Recurrent Neural Networks: Architectural Overview, Bidirectional RNNs – Encoder-decoder sequence to sequence architectures – Back-propagation Through Time for training RNN, Vanishing and Exploding Gradients, Long Short-Term Memory Networks, Gated recurrent Unit.

UNIT-V: Deep Unsupervised Learning: Auto-encoders, De-noising auto-encoders, Sparse auto-encoders, Variational Autoencoder. Generative Adversarial Networks(GANs) Introduction of GANs (Generative Modeling) , Different Types of GANs, Components of GANs, Training and Prediction of GANs, Brief on GAN Loss Function, Challenges Faced by GANs, Application of GANs.

TEXTBOOKS:

[T1] John Paul Mueller, Luca Massaron, Deep Learning for Dummies, John Wiley & Sons.
[T2] Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford.

REFERENCE BOOKS:

[R1] Adam Gibson, Josh Patterson, Deep Learning, A Practitioner's Approach, Shroff Publisher /O'Reilly Publisher Media.
[R2] Russell Reed, Robert J MarksII, Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks, Bradford Book Publishers.

WEB RESOURCE:

[W1] https://swayam.gov.in/nd1_noc20_ge09/preview.

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Deep Learning	Prof. Mitesh Kapra	IIT Madras

EEL-622: DEEP LEARNING LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	HDC-L

This laboratory course is designed based on theory course of "Deep Learning " (EEH-612). There experiments to be conducted by the students cover almost all units of theory course. The experiments include application of Kaggle enhance visibility, build general features to build a model for text analytics, build and deploy your own deep neural network on a website using tensor flow etc.

EEH-712: CRYPTOGRAPHY AND NETWORK SECURITY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites: Computer network

COURSE OBJECTIVES&COURSE DESCRIPTION: To understand basics of Cryptography and Network Security and able to secure a message over insecure channel by various means. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.To understand various protocols for network security to protect against the threats in the networks.

.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Acquire fundamental knowledge on the concepts of finite fields, number theory and cryptography.
CO2	To be able to secure a message over insecure channel by various means.
CO3	To learn about how to maintain the Confidentiality, Integrity and Availability of a data
CO4	Understand the various authentication mechanisms
CO5	Acquire the knowledge on firewall and security applications for networks.

UNIT-I: Introduction to security attacks, services and mechanism, introduction to cryptography, Conventional Encryption: Conventional encryption model, classical encryption techniques, substitution ciphers and transposition ciphers, cryptanalysis – steganography, stream and block ciphers, Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, fiestal structure, data encryption standard(DES), strength of DES, differential and linearcrypt analysis of DES, block cipher modes of operations, triple DES – AES

UNIT-II: Confidentiality using conventional encryption, traffic confidentiality, key distribution, random number generation, Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete algorithms.

UNI-III: Principles of public key crypto systems, RSA algorithm, security of RSA, key management – Diffle, Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography – Elgamel encryption, Message Authentication and Hash Function: Authentication requirements, authentication functions, message authentication code, hash functions, birthday attacks – security of hash functions and MACS.

UNIT-IV: MD5 message digest algorithm, Secure hash algorithm (SHA) Digital Signatures: Digital Signatures, authentication protocols, digital signature standards (DSS), proof of digital signature algorithm, Authentication Applications: Kerberos and X.509, directory authentication service, electronic mail security, pretty good privacy (PGP), S/MIME.

UNIT-V: IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. Web Security: Secure socket layer and transport layer security, secure electronic transaction (SET), System Security: Intruders, Viruses and related threads, firewall design principals – trusted systems.

TEXTBOOKS:

[T1] William Stallings, "Cryptography and Network Security", 3rd Edition, Pearson Education, 2003
[T2] Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security", Prentice Hall, 2nd edition, ISBN10: 0130460192, ISBN,13: 978,013046

REFERENCE BOOKS:

[R1] Charles Pfleeger," Security in Computing", Prentice Hall, 4th Edition, ISBN,10: 0132390779, ISBN,13: 978, 01323907744, 2006.
[R2] Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Private Ltd., New Delhi – 110001, 1999.

WEB RESOURCE:

[W1]http://nptel.ac.in/courses/106105031/
[W2] https://ocw.mit.edu/courses/electrical,engineering,and,computer,science/6,033, computer,system,engineering,spring,2009/video,lectures/

ALERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Cryptography and Network Security	Prof. D. Mukhopadhyay	IIT Kharagpur
2.	Cryptography and Network Security	Prof. S. Mukhopadhyay	IITKharagpur

EEP-713: PROJECT

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	PROJ

The objective of the project for Honours degree specialization is to develop and enhance students' analytical and problem tackling skills. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers. The project may be analytical, computational and experimental or combination of them based on AI and cyber security. During the project period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EEH-812: NATURAL LANGUAGE PROCESSING

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion

Pre requisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: This course aims to provide an in-depth understanding of various text and language processing tasks. Students will learn essential techniques for text normalization, lemmatization, and stemming, as well as gain insight into probabilistic language models and smoothing techniques. The course will also cover important concepts in text classification, sentiment analysis, and sequence modeling, including Hidden Markov Models (HMM) and Long Short-Term Memory (LSTM) networks. Additionally, the course will explore lexical and distributional semantics, focusing on word sense disambiguation and the use of word embeddings, as well as key information extraction techniques like Named Entity Recognition (NER) and Relation Extraction.

.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Preprocess and normalize text data, applying techniques like lemmatization, stemming, and the Max Match algorithm for text analysis..
CO2	Implement and evaluate probabilistic language models, including N-grams, bigram probabilities, and smoothing techniques..
CO3	Build and evaluate text classification models, including the use of Naïve Bayes classifiers and sentiment analysis algorithms.
CO4	Develop expertise in lexical semantics, applying methods like Word Sense Disambiguation (WSD) and utilizing tools such as WordNet to compute word similarities.
CO5	Understand and apply distributional semantics techniques, including word embeddings and dimensionality reduction, for effective representation learning and information extraction tasks.

UNIT-I: **Text Processing Tasks and Probabilistic Language Models**
Introduction to Text, Speech and Language Technologies, Basic Text Processing Tasks, Normalization, Max Match Algorithm, Lemmatization, Porter Stemmer, Minimum Edit Distance, Probabilistic Language Models: N Grams, Bigram Probabilities, Perplexity, Smoothing Techniques: La Place, Good Turing, Kneser Ney, Interpolation.

UNIT-II:. **Text Classification and Sequence Modelling**
Text Classification: Bag of words, Conditional Independence, Multinomial Naïve Bayes Classifier, Maximum Likelihood Estimation, Evaluation of Text Classification Model. Sentiment Analysis: Entity based and aspect Based Feature Extraction, Baseline Algorithm, Sentiment Lexicons, Polarity Analysis. Building Sentiment Lexicons: Semi supervised Algorithm, Turney Algorithm. Sequence Modelling: Markov Models, HMM, Beam, Greedy and Viterbi inference, HMM, CRF, LSTM based POS tagging.

UNIT-III:. **Lexical Semantics**
Word Senses and Word Relations, Wordnet. Computing Word Similarities: Path Based, Information Content, Word Sense Disambiguation, Thesaurus based WSD using Wordnet, Lesk Algorithm, Typical Features of WSD, Supervised WSD, Semi supervised WSD.

UNIT-IV:. **Distributional Semantics**
Vector Semantics: Distributed Representations, Word Context Matrix Generation, Weighting Methods, Dimensionality Reduction, Similarity Measures. Word Embeddings, Learning of Neural Embeddings.

UNIT-V:.**Information Extraction**
Named Entity Recognition: Hand Written Regular Expressions, Typical Features for NER, Classification models, Sequence Models. Relation Extraction: Binary Relation Association, Relation Extraction from Wikipedia, Supervised Relation Extraction, Semi-supervised Relation Extraction, Distant Supervision.

TEXTBOOKS/ REFERENCE BOOKS:

1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, 2nd Edition, Pearson Education, 2013.
2. Yoav Goldberg, “Neural Network Methods in Natural Language Processing”, Morgan & Claypool Publishers, 2017.
3. Steven Bird, Ewan Klein, Edward Loper “Natural Language Processing with Python”, O′Reilly, 2009.
4. Manning and Schuetze, “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.**WEB**

HONOURS DEGREE SPECILIZATION COURSES
(3. ENERGY AND GRID TECHNOLOGY)

EEH-413: ENERGY CONSERVATION AND MANAGEMENT

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Power Generation, SCADA System, Smart Grid, Electrical Power System

COURSE OBJECTIVES & COURSE DESCRIPTION: Energy Management has been identified as a key instrument to reduce greenhouse gas emissions, besides increasing the cost competitiveness of the entity/ facility while enhancing the energy security of the nation. Policy makers and technology providers have been working towards the cause of energy efficiency and its overall management. This course is designed to educate students on the various dimensions of energy management across the entire value chain.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Analyse energy systems from a supply and demand perspective
CO2	Impart knowledge in the domain of energy conservation.
CO3	Bring out Energy Conservation Potential and Business opportunities across different user segments.
CO4	Develop innovative energy efficiency solutions and demand management strategies

UNIT-I: Introduction to Energy Conservation:
Overview - Global & Indian Energy Scenario Energy Sources, Supply & Demand Overview of Electrical and Thermal Energy Imperative for Energy Conservation, Policy & Regulations for Energy Conservation.

UNIT-II: Energy Conservation Requirements:
Global EE Programmes India - Energy Conservation Policies, Energy Conservation Opportunities – Electrical Buildings & Lighting Systems Motors, Pumps, Transformers Power Transmission & Distribution System

UNIT III:Energy Conservation Opportunities:
Thermal Boilers, Furnaces & Waste Heat Recovery Systems Cogeneration Systems HVAC, Cooling Towers & DG Systems, Energy Data Analysis IT Tools and Applications Smart Energy Systems.

UNIT-IV:Case Studies:
Industrial Use Cases, Business Approaches Market Opportunities Overview on EE Financing ESCO Business Models Case studies

TEXTBOOKS:

[T1] LC Witte, PS Schmidt and DR Brown: Industrial Energy Management and Utilization (Hemisphere Publishing Corporation, Washington, 1998)

REFERENCE BOOKS:

[R1] WC Turner and Steve Doty: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
[R2] Sumper Andreas and Baggini Angelo: Electrical Energy Efficiency: Technologies and Applications (John Wiley 2012)
[R3] Frank Kreith: Handbook on Energy Efficiency and Renewable Energy (CRC Press, 2007)
[R4] George Polimeros: Energy Cogeneration Handbook (Industrial Press, Inc., New York, 1981)

Websites:

[W1] National Productivity Council (http://www.npcindia.gov.in)
[W2] Bureau of Energy Efficiency (https://www.beeindia.gov.in)
[W3] Petroleum Conservation Research Association (http://www.pcra.org)

EEH-513: ENERGY ECONOMICS AND AUDITING

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Fundamentals of Power systems

COURSE OBJECTIVES & COURSE DESCRIPTION: This course aims to provide students an understanding of the economic fundamentals and principles of decision making involved in energy projects. The course also sensitize the students on the mechanism of energy audit and the technologies/ tools typically employed to undertake an audit exercise, supported by case study.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Understand the basics of engineering economics
CO2	Understand the structure of energy markets and methods used for pricing electricity and other forms of energy.
CO3	Evaluate the cost effectiveness of individual renewable energy projects.
CO4	Gain knowledge on tools and techniques employed in energy auditing
CO5	Comprehend an energy audit report, including economic parameters

UNIT-I: Basics of engineering economics: Role of engineering economics in the decision-making process, Economic decisions versus design decisions, discount rate and economic equivalence, worth analysis, rate-of-return analysis, depreciation, and taxation, developing project cash flows, social cost benefit analysis, origins of renewable energy project risks, sensitivity and, break-even analysis, expected value decisions.

UNIT-II: Energy Modelling: Review of Energy Prices and Markets, review of various energy sector models, energy demand analysis and forecasting, energy supply assessment and evaluation, energy demand – supply balancing, energy modelling in the context of climate change

UNIT-III: Techno-economic evaluation of Renewable Energy Technologies: Technology dissemination models, dynamics of fuel substitution by renewable energy systems and quantification of benefits, fiscal, financial and other incentives for promotion of renewable energy systems and their effect on financial viability, case studies on financial feasibility evaluation of renewable energy devices and systems.

UNIT-IV: Energy Audit Basics: Definition and Objectives, types, Energy Profiling, Energy Flow diagram, Types of Energy Audit, Duties of Energy Auditor & Manager.

UNIT-V: Energy Audit Procedure: Energy Audit Procedure Tools/Techniques/Equipment, Energy Audit Report, Financing EEC Activities. Case study on energy audit in Power Distribution Utilities.

TEXTBOOKS:

[T1] G. J. Thuesen and W. J. Fabrycky, "Engineering economy". Prentice Hall of India.
[T2] T.C. Kandpal and H.P. Garg, "Financial Evaluation of Renewable Energy Technologies", Macmillan India.
[T3] LC Witte, PS Schmidt and DR Brown," Industrial Energy Management and Utilization", Hemisphere Publishing Corporation, Washington, 1998.

REFERENCE BOOKS:

[R1] C. Dahl, "International Energy Markets: Understanding Pricing, Policies, & Profits". PennWell Books.
[R2] S. Kaplan, "Energy economics: quantitative methods for energy and environmental decisions". McGraw-Hill College.
[R3] YP Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI Press, 2006.
[R4] WC Turner, "Energy Management Handbook", Seventh Edition, Fairmont Press Inc., 2007.

WEB RESOURCE:

[W1] https://onlinecourses.swayam2.ac.in/nou23_es05/preview
[W2] Bureau of Energy Efficiency (https://www.beeindia.gov.in/)
[W3] National Productivity Council (http://www.npcindia.gov.in/)

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL/SWAYAM Course Name	Instructor	Host Institute
1.	Basic Principles of Energy Management & Energy Audit	Dr. R. N. Patel & Mr. Akhilesh Kumar Tiwari	Chhattisgarh Swami Vivekanand Technical University

EEH-613: RENEWABLE ENERGY RESOURCE CHARACTERISTICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites: Energy Conservation and Management

COURSE OBJECTIVES & COURSE DESCRIPTION: This subject introduces the different renewable energy sources to the students. Students get knowledge of Electric Power generation by wind, solar, small hydro, Biomass, Fuel Cell and MHD. The course is designed to familiarize and train the student with the tools and techniques used to assess the various renewable energy resources and its potential at any location across the globe, so that a student is able analyse a case quantitatively at the end of the term.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Summarize, classify and compare types of renewable energy sources, outline as per Global and Indian context.
CO2	Utilize solar energy for various applications, estimate solar radiation geometry
CO3	Select a site for wind energy source
CO4	Understand the characteristic of biomass energy.
CO5	Demonstrate, Classify and utilize small hydro, geothermal and ocean energy.

UNIT-I: INTRODUCTION TO ENERGY SOURCES
World Energy Futures, Conventional Energy Sources, Renewable Energy Sources, Prospects of Renewable Energy Sources. Environmental aspects of Electrical Energy Generation..

UNIT-II: : SOLAR ENERGY RESOURCES
Solar radiation: Spectrum of EM radiation, sun structure and characteristics, extra-terrestrial radiation, solar constant, air mass, beam, diffused and total solar radiation, spectral distribution Sun-earth movement in different seasons, solar geometry, solar radiation on tilted surface, local apparent time, irradiance, insolation Attenuation of solar radiation by the atmosphere, albedo, beam and diffuse components of hourly and daily radiation, GHI and DNI, clearness index, Radiation augmentation Different climatic zones and their impact on site selection
Measurement of solar radiation: Instruments: sunshine recorder, Pyranometer, Pyrheliometer, Albedometer. Radiation measurement stations in India (NIWE, IMD etc.), Hands-on measurement of beam, diffuse and total radiation.
Models and methods for estimating solar radiation, estimation of global radiation, estimation of diffused components

UNIT-III: WIND ENERGY
Introduction to wind energy Conversion, the nature of the wind, Power in the wind. Wind Energy Conversion: Wind data and energy estimation, Site Selection Considerations, Worldwide development.
Introduction to Atmospheric Boundary Layer Theory, Wind gradient and geographical importance, Wind energy database-Wind atlas.
Wind Systems in India as Case, Potential sites, diurnal and seasonal variations, Instruments used and measurement process wind data.

UNIT-IV: BIOMASS
Basics: Biomass resources: plant derived, residues, aquatic and marine biomass, various wastes, photosynthesis.
Biomass resource assessment: Estimation of woody biomass, non woody biomass and wastes, ASTM standards.
Bulk chemical properties: Moisture content, proximate and ultimate analyses, calorific value, waste water analysis for solids.
Chemical composition of biomass: Cellulose, hemicelluloses and lignin content in common agricultural residues and their estimation, protein content in biomass, extractable, COD.
Structural properties: Physical structure, particle size and size distribution, permeability. Physical properties: Bulk density, angle of repose, thermal analysis (thermogravimetric, differential thermal and differential scanning calorimetry).Properties of microbial biomass: Protein estimation, flocculating ability, relative hydrophobicity of sludge, sludge volume index.

UNIT-V: SMALL HYDRO RESOURCES, GEOTHERMAL AND OCEAN RESOURCES
Small Hydro: Indian resource potential and exploitation, power potential estimation, hydrographs. Methods for determining head and flow, head and flow measurements, site evaluation, cartography, geotechnical studies.

Geothermal and Ocean Energy: Heat mining, potential sites, Darcy's law, volcano related heat resources, sedimentary basins, hot dry rocks, estimation of wave power, tidal power sites, scatter diagram of wave heights, OTEC resource map.

TEXTBOOKS:

[T1] B.H. Khan, "Non Conventional Energy Resources", McGraw Hill Education India Private Limited ·.
[T2] VVN Kishore, "Renewable Energy Engineering and Technology – A Knowledge Compendium, TERI Press, 2008.

REFERENCE BOOKS:

[R1] Donald Klass, "Biomass for Renewable Energy, Fuels, and Chemicals", Entech International Inc., USA.
[R2] JA Duffie and WA Beckman, "Solar Engineering of Thermal Processes", Third Edition, John Wiley & Sons.
[R3] S Sukhatme and J Nayak, "Solar Energy: Principles of Thermal Collection and Storage", Third Edition, Tata McGraw Hill, 2008.

WEB RESOURCE:

[W1] https://archive.nptel.ac.in/courses/
[W2] https://mnre.gov.in/
/ ,

EEL-623: GRID TECHNOLOGY LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	HDC-L

A Grid Technology Lab focuses on the practical implementation and experimentation with grid computing and energy management systems. In this lab, students gain hands-on experience in understanding and configuring distributed computing systems, including smart grids and renewable energy integration into power networks. The lab provides a platform for exploring technologies such as demand response, energy storage, and monitoring and control of electrical grids. By simulating various grid scenarios, students can analyze the performance, efficiency, and scalability of grid systems, as well as investigate solutions to enhance grid stability, reliability, and sustainability.

EEH-713: GRID INTEGRATION OF RENEWABLE ENERGY

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classroom instruction will consist of interactive lectures, class discussions, PowerPoint presentations, and video illustrations.

Pre requisites: Basic understanding of Power System and Power Electronics Engineering.

COURSE OBJECTIVES & COURSE DESCRIPTION:
The characteristics and behaviour of power systems changes when the share of variable energy increase in the total mix. With the increase in penetration from renewable energy sources, the dynamics of the existing electricity infrastructure must be understood. This course provides a platform for strong understanding related to the phenomenon of integrating renewable energy sources. The course is focussed on causes, effects and recovery measures when power from renewable energy sources are injected to the grid.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Acquire a strong understanding of power systems, their operation and control focussed on the issues related to the integration of distributed renewable generation into the network.
CO2	Apply advanced knowledge of electrical power system operations and control to analyse the challenges and opportunities for distributed renewable generation in both large interconnected grid and microgrid settings.
CO3	Describe the principles and requirements of the next generation future power network, incorporating distributed generation and storage and demand management
CO4	Understand the principles, power and limitations of complex power networks incorporating distributed generation and storage

UNIT-I: Introduction of various techniques of utilizing power from renewable energy sources, concept of nano/micro/mini grid. Need of integrating large renewable energy sources, issues related to integration of large renewable energy sources, rooftop plants. Concept of VPP.

UNIT-II: Power system equipment for grid integration Synchronous generator: synchronization/integration to existing grid, load sharing during parallel operation, stability (swing equation and solution) Induction Generator: working principle, classification, stability due to variable speed and counter measures Power Electronics: need of power electronic equipment in grid integration, converter, inverter, chopper, ac regulator and cyclo-converters for AC/DC conversion

UNIT-III: Power quality and management Importance of power quality and corresponding standards, THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, system protection, grid codes

UNIT-IV: Grid stabilization Scheduling and dispatch, Forecasting, reactive power and voltage control, frequency control, operating reserve, storage systems, electric vehicles Ancillary services in Indian Electricity Market (regulatory aspect),CERC and CEA orders (technical and safety standards)

UNIT-V: Integration of alternate sources of energy Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection, Case studies based on synchronous/induction generator for peak demand reduction, grid connected PV system.

TEXTBOOKS/REFERENCE BOOKS:

1. Integration of Alternative sources of Energy, IEEE Press –Wiley-Interscience publication, 2006.
2. Grid integration of solar photovoltaic systems, M. Jamil, M. Rizwan, D.P. Kothari, CRC Press(Taylor & Francis group), 2017
3. Renewable Energy Grid Integration, Marco H. Balderas, Nova Science Publishers, New York, 2009.
4. Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, IET Power and Energy Series 50 (IET digital library), 2007
5. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, John Wiley & Sons, New York, 2013 (3rd edition)
6. Power Electronics: Circuits, Devices, and Applications. M. H. Rashid, Pearson Education India, 2013
7. Advanced power system analysis and dynamics, L.P. Singh, New age international publishers,2017

EEP-713: PROJECT

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	PROJ

The objective of the project for Honours degree specialization is to develop and enhance students' analytical and problem tackling skills. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers. The project may be analytical, computational and experimental or combination of them based on energy management and grid technogies. During the project period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EEH-813: DISTRIBUTED GENERATION AND MICRO GRID TECHNOLOGIES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	HDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Pre requisites:

COURSE OBJECTIVES & COURSE DESCRIPTION: This subject introduces the concept of distributed generation to the students. It also familiarizes the students with the concept of microgrid and its configuration. Through this course the students will develop the skill to find optimal size, placement and control aspects of DGs.

COURSE OUTCOMES: After successfully completing the course, students should be able to:

CO1	Find the type, size and optimal placement DG and storage systems.
CO2	Analyze the impact of DGs grid integration and its control aspects
CO3	Describe the operational impacts and performance analysis of DGs connected to integrated power systems
CO4	Analyze the Micro Grid taking into consideration the operational and control issues of the DGs.
CO5	Understand the necessity of Micro Grid protection

UNIT-I: Distribution Generation (DG) and Storage Technologies
Introduction, Definition and Benefits of DG, Distributed generation (DG) overview and technology trend, Renewable and Non-renewable DG Technologies. Comparison amongst different DG technologies, Brief overview of various Distribution Generations.
Concept of distributed generations (DG) or distributed energy resources (DERs) topologies, Renewable DG Technologies: PV, Wind, Fuel Cell, micro hydro. Hybrid system. Classification and comparison of Energy Storage Systems (ESS), Battery, Super Capacitor, Flywheel, SMES, etc. Optimal placement of DG sources in distribution systems.

UNIT-II: : Operational benefits of Grid connected Renewable DG systems
Benefits of Renewable DG integration on :Reliability of Distribution System (Methods of improving reliability, reliability indices), Power loss reduction (optimal sizing of DG), Voltage profile improvement, Economic benefits, Emission reduction

UNIT-III: Technical impacts of DGs on Grid
Grid interconnection issues for grid connected operation of various types of DG systems.nImpact of DGs upon transient and dynamic stability, grid power quality, and protective relaying of existing distribution systems.

UNIT-IV: Introduction and Operation Control and Modeling of Micro Grid
Concept and definition of Micro Grid, Types of Micro Grid (AC, DC and Hybrid AC-DC), review of sources of Micro Grid, typical structure and configuration of a microgrid, Autonomous and non-autonomous grids, Sizing of Micro Grid, Micro grid with multiple DGs – Power Electronics interfaces in DC and AC microgrids, communication infrastructure, Micro Grid implementation in Indian and international scenario.

UNIT-V: Controls & Protection of Micro Grid
Control techniques for voltage, frequency, active and reactive power control of AC Micro Grid system, transients in Micro Grid, Protection of Micro Grid. DC Microgrid: Unipolar and Bipolar LVDC.

TEXTBOOKS:

[T1] H. Lee Willis, Walter G. Scott," Distributed Power Generation – Planning and Evaluation", Marcel Decker Press.
[T2] Robert Lasseter, Paolo Piagi, "Micro Grid: A Conceptual Solution", PESC, 2004.

REFERENCE BOOKS:

[R1] M.Godoy Simoes, Felix A.Farret, "Renewable Energy Systems – Design and Analysis with Induction Generators", CRC Press.
[R2] S. Chowdhury, S.P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks', The Institution of Engineering and Technology, London, U.K.

WEB RESOURCE:

[W1] https://archive.nptel.ac.in/courses/
[W2] https://mnre.gov.in/

MINOR DEGREE SPECIALIZATION COURSES (ELECTRIC VEHICLE AND AUTOMATION)

EED-411: POWER ELECTRONICS FOR ELECTRIC VEHICLE

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	OEC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Pre requisites:

COURSE OBJECTIVES & COURSE DESCRIPTION: The course objectives for an undergraduate (UG) Power Electronics & Electric Vehicle (EV) course typically aim to provide students with a fundamental understanding of power electronics and its use in Electric Vehicle applications . These objectives include the following topics to be taught : Introduction of Power Electronics, Semiconductor devices, Power semiconductor switching, Converter topologies for EV application, control techniques etc.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain basics of Power electronics, device operation and its control.
CO2	Analyze the operation of uncontrolled and fully control rectifiers along with expressions of fourier series for EV applications.
CO3	Apply the circuit topology to get the operation of DC-AC converters and AC-AC converters for EV application.
CO4	Understand the process of operation of DC-DC converters along with its control for EV application.
CO5	Discuss various control techniques and few advance topics with understanding of related simulation software for EV application.

UNIT-I:

Introduction, Devices: Diodes-silicon, fast recovery, Schottky diode, SCR,TRIAC, SCS, GTO, PUT, SUS, CUJT, LASCR, Mosfet, IGBT with their V-I characteristics. SCR: Operating principle, Gate Characteristics, Two transistor model, over-current and over voltage protection, snubber circuits, methods of turning on (triggering) and turning off (commutation). Fundamentals of SiC, GaN devices.

UNIT-II:
Fundamentals of AC- DC converters. AC- DC converters topologies for Electric Vehicle, Application, Design and Control. Performance parameters of AC-DC converters for Electric Vehicle

UNIT III:

Fundamentals of DC-AC Converters, types. DC-AC converters topologies for Electric Vehicle application: design and control. Performance parameters of DC-AC converters for Electric Vehicle.

UNIT-IV

Fundamentals of DC- DC converters, Bidirectional DC-DC converter. DC-DC converters topologies, Bidirectional DC-DC converter topologies for Electric Vehicle application: design and control. Performance parameters of DC-DC converters for Electric Vehicle.

UNIT-V:

Advance applications of Power Electronics in EV charging station, onboard chargers/ off board chargers, Solar PV technology, Simulation software: PSIM, Real time HIL.

TEXTBOOKS:

[T1] M. H. Rashid, “Introduction to Power Electronics- Circuits, devices and application”, Pearson Education India, New Delhi.
[T2] A Haque, M A Khan, K V S Bharath, “Design and Control of Grid connected PV System” CRC Press, USA.

REFERENCE BOOKS:

[R1] P. C. Sen, “Power Electronics” Tata McGraw Hill Book Co., New Delhi.
[R2] G. K. Dubey, S.R. Doradla, A.Joshi and R.M.K. Sinha, “Thyristorised Power Controllers” ,Wiley Eastern Ltd., New Delhi.

WEB RESOURCE:

[W1] www.nptel.ac.in

EED-511: ELECTRIC VEHICLE CONTROL SYSTEMS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	MDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar etc.

Prerequisites:

To understand this course, the student must have idea of:

Sl. No.	Subject	Description	Level of Study
01	Mathematics	Linear Differential Equations, Laplace Transform	Class XII, 2nd Sem
02	Physics	Rotational Motion	Class XI
03	Circuit Theory	Network Theory	3rd Sem

COURSE OBJECTIVES & COURSE DESCRIPTION:

- Understand the principles of control systems and their applications in electric vehicles.
- Develop mathematical models of EV components and analyze their dynamic behavior.
- Design and simulate control strategies for key EV functionalities.
- Apply advanced control techniques to improve EV performance and energy management..

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Simplify and analyze complex control system block diagrams using algebra and signal flow graphs.
CO2	Analyze the dynamic behavior of EV systems and their components.
CO3	Perform time domain analysis of first and second-order systems.
CO4	Implement energy management strategies using modern control techniques.
CO5	Implement and evaluate advanced control strategies for EV subsystems.

UNIT-I: Introduction: Concept of feedback and Automatic control, Effects of feedback, Objectives of control system. Types of control systems. Merits and demerits of open and closed loop control systems, Transfer function concept.
Mathematical modeling of dynamic systems: Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring– Mass-Dashpot system. Mathematical modelling of electrical systems. Analogous systems, Force-current analogy, Force –voltage analogy. Mathematical modelling of electromechanical systems. Mathematical modeling of mechanical, electrical, thermal, hydraulic and pneumatic systems.

UNIT-II: Block diagram representation of control systems. Block diagram algebra. Block diagram reduction rules. Overall transfer function of complex block diagrams. Signal flow graph. Mason's gain formula.
Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tacho-generators. Actuators. Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, Servomechanisms and regulators.

UNIT-III: Time domain analysis: Time domain analysis of a first and standard second order closed loop system. Time Response Specifications, Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems.
Error Analysis: Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.

UNIT-IV: Stability Analysis in Time Domain: Stability concept, Necessary conditions for stability. Routh-Hurwitz's stability criterion, Root locus techniques, construction of Root Loci for simple systems. analysis of control system by root loci. Sensitivity of the roots of the characteristic equation. Relative stability analysis. Effects of gain on the movement of Pole and Zeros.

UNIT-V: **Frequency domain analysis of linear system**: Relationship between time and frequency response, Procedure to plot Polar plot, Bode plots, Determination of margin of stability in Bode plot, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin.

TEXTBOOKS:

1) I. J. Nagrath and M. Gopal, "Control Systems Engineering" New Age International Ltd , New Delhi, 7th Edition
2) Norman S. Nise, "Control System Engineering", 7th Edition, Wiley
3) Kou, B.C., "Automatic Control System", Prentice Hall of India Pvt. Ltd., New Delhi.
4) Ogata, K., "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., New Delhi.
5) Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Wiley.
6) Krishnan, R. "Electric Motor Drives: Modeling, Analysis, and Control." Prentice Hall.
7) Xi Zhang & Chris Mi, "Vehicle Power Management: Modeling, Control and Optimization." Springer.
8) Wei Liu, "Introduction to Hybrid Vehicle System Modeling and Control", Wiley.

WEB RESOURCE :

1. https://www.controleng.com
2. https://www.mathworks.com
3. https://nptel.ac.in/courses/108/102/108102043/

EED-611: ELECTRIC VEHICLE ENERGY SYSTEM

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	MDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Basic Electrical Engineering, Power Electronics for EVs

COURSE OBJECTIVES&COURSE DESCRIPTION: This course aims to provide students with an in-depth understanding of energy systems used in Electric Vehicles (EVs).The students will be to understand different energy sources, storage technologies, and energy management strategies.

COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Understand the fundamentals of energy systems and their components in Electric
CO2	Analyze battery technologies for Electric vehicles..
CO3	Apply the concepts of battery management system in Electric vehicles.
CO4	Explore alternative energy storage technologies for Electric vehicles.
CO5	Apply energy management strategies in Electric vehicles.

UNIT-I: Introduction to Electric Vehicle Energy Systems
Overview of Electric Vehicles (EVs), Basic structure of EV energy systems, Comparison of internal combustion engine (ICE) vehicles vs. electric vehicles, Energy flow and efficiency considerations in EVs, EV classification and their electrification levels, Power and energy requirements of various types of EVs such as 2/3/4 wheelers, trucks and buses etc., Environmental impact and benefits of EVs, Future of EVs.

UNIT II: Battery Technologies
Types of Battery, Introduction to Electrochemical Battery, Electrochemical Reactions, Battery Parameters: Cell and Battery voltage, Battery Capacity, Discharge Rate, Charging Rate, State of Charge (SOC), State of Discharge (SOD), State of Health (SOH), Depth of Discharge (DOD), Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency, Battery Technologies: Lead-Acid Battery, Nickel Based Battery, Lithium Battery (Li-ion Li-Polymer), Role in Electric Drive Train, Selection of battery for EVs & HEVs

UNIT III: Battery Management Systems (BMS)
Introduction to BMS, Objectives of BMS, Discharging control, Charging control, State-of-Charge Determination, State-of-Health Determination, Cell Balancing, Energy & Power estimation; Battery thermal management system, BMS topologies: Distributed Topology, Modular Topology and Centralized Topology, Firmware development, Certification, Aging. Battery Standards & Tests.

UNIT IV: Alternative Energy Storage
Fuel Cell: Overview of Key Fuel Cell Technologies – Various Types of Fuel Cells, Materials for Electrodes, Electrolytes and Other Components, Working Mechanisms, Hydrogen Generation and Storage: Limitations, Recent Progress in Fuel Cells, Safety Issues and Cost Expectation and Life Cycle Analysis of Fuel Cells; Supercapacitors, Flywheel

UNIT V: Energy Management Systems
Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.
EV charging standards, Vehicle to Grid (V2G), Grid to Vehicle (V2G), Vehicle to Home (V2H) technologies.

TEXT BOOK:

[T1] James Larminie, John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2003.

REFERENCE BOOKS:

[R1] Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
[R2] Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
[R3] S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
[R4] Ibrahim Dinçer, Halil S. Hamut and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems”, John Wiley & Sons Ltd., 2016.

EEL-624: ELECTRIC VEHICLE LAB

L	T	P	Credit	Assessment:	Type of Course
0	0	2	1	Mid Sem.60%+ End Sem.40% =100%	MDC-L

This laboratory course is designed to equip the students with experiments related to the application of power electronics in electric vehicles and electric vehicle drives. It also enabled the students to use the AI and optimization tools of EVs. It consists of 8-10 experiments which includes single phase rectifier fed DC shunt and DC series motor, operation of Universal motor , V/f control of a3-phaseinduction motor, inverter fed BLDC motor, DC-DC and DC-AC converter for ElectricVehicle etc.

EED-711: ELECTRIC VEHICLE DRIVES

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
2.5	0.5	0	3	Mid Sem.40%+ End Sem.60% =100%	MDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies, Group discussion, Seminar & field work etc.

Pre requisites: Electric machines

COURSE OBJECTIVES&COURSE DESCRIPTION: This course aims to provide the students with a comprehensive understanding of Electric Vehicle drives and its control involved in starting, speed regulation, braking, and reversal. It also aims to provide the students with an understanding of the application of power electronic converters for controlling the electric vehicle drives

COURSE OUTCOMES: After the completion of the course;

CO1	Student will be able to demonstrate the knowledge of particular type of AC/DC drives.
CO2	Student will use the knowledge for the analysis the DC drive system.
CO3	Student will be able to analyze the AC drive systems.
CO4	Students will be able to effectively apply the knowledge of drives for closed-loop systems.
CO5	Student will be able to analyze applications of solar powered drives and traction drives.

UNIT-I: Introduction, concept of electric drives, EV drives -classification and components, characteristic, starting, speed control and braking of electric motors (dc and ac), Electro-mechanical transients during starting and braking, time energy calculation, load equalization.

UNIT-II: Converters for feeding electric vehicle motors – line commutated converters, choppers, inverters, cycloconverters, ac voltage controllers.

UNIT III: Induction motor drive systems for EVs, scalar control, vector control, sensor less control.

UNIT-IV: Permanent magnet motor drive system for EVs, Energy conservation in Electric drives. Switched Reluctance Motor Drive Systems for EVs.

UNIT-V: Solar and battery powered drives Solar powered EVs, Traction drives, mainline and suburban train configurations, Application of polyphase ac motors in traction drives

TEXTBOOKS:

[T1] G K Dubey, Power Semiconductor Controlled Drives, Prentice Hall Englewood Cliffs, New Jersey.

REFERENCE BOOKS:

[R1] S. K. Pillai, A First Course in Electric Drives, New Age Publications, New Delhi.
[R2] P C Sen, Principles of Electric Machines and Power Electronics, John Wiley.
[R3] M. H. Rashid, “Introduction to Power Electronics”, Pearson Education India, New Delhi.
[R4] G. K. Dubey, Fundamentals of Electric Drives, Narosa Publications, New Delhi.

WEB RESOURCE :

[W1] https://archive.nptel.ac.in/courses/108/104/108104140/

ALTERNATIVE NPTEL/SWAYAM COURSE:

S. No.	NPTEL Course Name	Instructor	Host Institute
1.	Industrial Drives	Dr. K .R. Rajagopal	IIT Delhi
2.	Advanced Electric Drives	Dr. S.P. Das	IIT Kanpur
3.	Fundamentals of Electric Drives	Prof. Shyama Prasad Das	IIT Kanpur
4.	Industrial Drives - Power Electronics	Prof. K. Gopakumar	IISc Bangalore

EEP-721: PROJECT

L	T	P	Credit	Assessment:	Type of Course
0	0	4	2	Mid Sem.60%+ End Sem.40% =100%	PROJ

The objective of the project is to develop and enhance students' analytical and problem tackling skills in the area of Electric Vehicle. Also it is expected that the students must learn to use the latest equipment and software so that the Industry gets trained Engineers. The project may be analytical, computational and experimental or combination of them based on electric vehicles. It should consist of objectives of study, scope of work, critical literature review, methodology and results. During the project period, every student has to present the progress of their works before the duly constituted committee of Faculty Members of the department. The assessment by the committee members are a part of Mid Term Evaluation. A report of the project in the form of hard copy must be submitted in the office before the final evaluation by the External Examiners.

EED-811: AI AND ML APPLICATION IN ELECTRIC VEHICLE

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	MDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Prerequisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: The objective of the course "AI and ML Application in Electric Vehicle is to understand the principles of artificial intelligence (AI) and machine learning (ML) ,Explore the applications of AI/ML in electric vehicles (EVs), Learn to design and develop AI/ML models for optimizing EV systems, Analyze real-world case studies of AI/ML in EV technology.

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COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain basics of electric vehicle and Fundamentals of AI & ML.
CO2	Analyze the fundamentals of battery management system, power train optimization
CO3	Apply the knowledge autonomous drive system & Smart Charging Infrastructure
CO4	Understand the fundamentals of Data analytics in EVs and Cyber security in AI enabled EVs.
CO5	Discuss the case studies and industry trends along with hands on capstones

UNIT-I:

Overview of EV architecture and components, Challenges in EV technology, Role of AI and ML in EV development, Basics of AI and ML: Definitions, Types (Supervised, Unsupervised, Reinforcement Learning, Overview of Deep Learning and Neural Networks, Tools and platforms for AI/ML (Python, Tensor Flow, PyTorch, etc.

UNIT-II:
Battery state estimation using ML (SOC,SOH,SOP), Predictive maintenance using AI, Thermal management in batteries with AI-based optimization, ML-based motor control and optimization, AI for energy management systems, Predictive analytics for drive train efficiency

UNITIII:

AI algorithms for autonomous navigation (path planning, object detection), Sensor fusion and perception in autonomous EVs, Deep learning for computer vision applications in EVs, AI-based smart charging optimization, Load forecasting and demand-side management, Integration of EVs with renewable energy grids

UNIT-IV

Big data analytics for EV performance, AI for fleet management in electric vehicles, Predictive analytics for driver behavior and efficiency, Threat modeling in connected EVs, AI for detecting and preventing cyber threats in EV systems, Secure communication protocols

UNIT-V:

Real-world applications of AI/ML in EV startups and companies, Tesla, Rivian, and other pioneers in AI/ML-driven EV technology, Challenges and ethical considerations, Develop an AI model for EV battery state prediction, Build a simple reinforcement learning model for energy optimization, Real-time analysis of EV fleet data using ML

TEXTBOOKS:

[T1] AI for Power Electronics, Haque, Azra, Saad, IEEE Wiley Press 2025
[T2] Deep Learning for Autonomous Vehicles by Seth Russell, Springer 2019
[T2] Machin eLearning for Predictive Models by John D. Kelleher, MIT Press,2015

WEBRESOURCE:

[W1] www.nptel.ac.in

EED-812: ELECTRIC VEHICLE ADVANCE TECHNOLOGIES AND ECONOMICS

L	T	P	Credit	Assessment:	Type of course	Total No. of Teaching Hours
3	0	0	3	Mid Sem.40%+ End Sem.60% =100%	MDC	42

Pedagogy: Classrooms lecture, Tutorial, Case studies.

Prerequisites:

COURSE OBJECTIVES&COURSE DESCRIPTION: The course objectives for a course on "Electric Vehicle Advance Technologies & Economics" aims to provide students with a strong foundation in the principles, technologies, and practical applications of electric vehicle (EV) system and related Economics. This includes the basic to advance knowledge of EV charging infrastructure requirements and design.

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COURSE OUTCOMES: After successfully completing the course, students should be able to

CO1	Explain basics of electric vehicle and its architecture.
CO2	Analyze the fundamentals of battery, BMS ,power electronics and drive technology for EVs
CO3	Apply the knowledge to plan and design the EV charging infrastructure
CO4	Understand the requirement of power electronics, control with standards for EV charging station along with Energy management system.
CO5	Discuss economical aspects of electric vehicle charging management system

UNIT-I:

History and evolution of Electric vehicles. Overview of Electric Vehicles and their types. Environmental and economic considerations. Electric Vehicle Architecture and components. Government policies and Industry specifications.

UNIT-II:

Fundamentals of Battery parameters. Battery technology and management system. Supercapacitors-Technology and management, Electric Motors and drive trains for EVs. Motor Control techniques. Power Electronics for electric vehicle drives.

UNITIII:

Electric Vehicle charging infrastructure: Types of EV chargers (Level 1, Level 2, DC Fast Chargers), Charging standards (ChadeMo, CCS, Tesla supercharges) , Charging infrastructure deployment and challenges, Smart Charging and Vehicle to Grid, Grid to vehicle charging concepts.

UNIT-IV

Power Electronics and control systems for charging of EVs (Battery, Battery with Supercapacitors etc). Charging cables and connectors, Safety standards and protocols. Charging station design and installation -A case study. Electric Vehicle Energy Management: Energy consumption, modelling and estimation, Battery state of charge and state of health monitoring, thermal management in EVs, Reliability analysis of EV converters (with Advance techniques – Image Processing, AI etc).

UNIT-V:

Economic analysis of EV charging station and its operation: Load Scheduling, Load prediction, Cost analysis, Case Study

TEXTBOOKS:

[T1] Advanced Electric Drive Vehicles Editor: Ali Emadi, CRC Press

[T2] Smart Charging Solutions for Hybrid and Electric Vehicles, Sulabh Sachan, P. Sanjeevi Kumar, Sanchari Deb, Wiley Press.

WEBRESOURCE:

[W1] www.nptel.ac.in