Haldia Institute of Technology

ICARE Complex, Hatiberia, Haldia, Dist-PurbaMedinipur, Pin-721657, WB.

(An Autonomous Institution under Maulana Abul Kalam Azad University of Technology)

Curriculum for B. Tech. in Electrical Engineering

(Applicable from the Academic Session 2024-2025)

Department of Electrical Engineering

VISION

To be a fore runner in Electrical Engineering education, research and profession and will facilitate the growth of Electrical Engineering graduates with dynamic capabilities of accepting new challenges.

MISSION

M1: The primary mission of the Department of Electrical Engineering is to produce quality human resources with capacity to serve the fraternity in a wide variety of roles including science, engineering, teaching, research, entrepreneurship and management.

M2: Putting emphasis on areas such as communication skills, professional and ethical responsibility, lifelong learning and contemporary issues to complement the technical aspects of the engineering course.

M3: To ensure a combination of engineering and complementary course works in the curriculum so that Electrical Engineering graduates are well-rounded, able to work effectively in team settings and able to adapt to different work environments.

Departmental of Electrical Engineering

PROGRAMME EDUCATIONAL OBJECTIVES:

PEO1: Graduates will demonstrate a strong foundation in science, mathematics and electrical engineering essential for building progressive careers in industry and higher education.

PEO2: The graduates will be able to exhibit professional ethics, human values and eagerness to become contributors to the society through their problem-solving skills and technical capability.

PEO3: Graduates will be able to exhibit their knowledge and technical skills to provide innovative, safe and sustainable solutions to practical problems in their field of work.

PEO4: Graduates will engage themselves in lifelong learning and continued professional development by acquiring new skills.

PROGRAM SPECIFIC OUTCOMES:

PSO1: Graduates will acquire the concepts of electrical engineering to develop the logical and technical skills for solving practical problems in the areas of Power System and Electrical Drives.

PSO2: Graduates will develop the ability to relate the theoretical concepts to practical applications through laboratory experiments using appropriate hardware setups and associated software utilities.

PSO3: Graduates will cultivate innovative ideas in the field of Electrical Engineering as well as multidisciplinary areas to make significant contributions to society.

Program Outcomes (PO):

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

PO2: **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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(Applicable from the Academic Session 2024-2025)

SEMESTER - I

Theory

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-M101	Mathematics –I	3	1	0	4	4
2	BS-PH101	Physics	3	1	0	4	4
3	ES-EE101	Basic Electrical and Electronics Engineering	3	1	0	4	4
4	BS-BT101	Biology for Engineers	2	0	0	2	2
Total Theory						**14**	**14**

Practical/ Sessional

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-PH191	Physics Laboratory	0	0	3	3	1.5
2	ES-EE191	Basic Electrical and Electronics Engineering Laboratory	0	0	3	3	1.5
3	ES-ME191	Workshop Practice	0	0	3	3	1.5
Total Practical / Sessional						**9**	**4.5**
Total Semester						**23**	**18.5**

For Honours, Course in B. Tech. (As per New guideline of AICTE/MAKAUT), total 20 credits are required over four years in the following way:
For first year 8 credits
For second year 4 credits
For third year 4 credits
For fourth year 4 credits
A student in 1st year has to covers from at least three (03) skills:
1. Computer Programming
2. Soft skill
3. Ethics

SEMESTER – II

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Theory

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-M201	Mathematics-II	3	1	0	4	4
2	BS-CH201	Chemistry	3	1	0	4	4
3	ES-CS201	Programming for Problem Solving	3	1	0	4	4
4	HS-MC201	Values, Ethics and Indian Knowledge System	2	0	0	2	2
5	HM-HU201	English Language and Technical Communication	2	0	0	2	2
Total Theory						**16**	**16**

Practical/ Sessional

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-CH291	Chemistry Laboratory	0	0	3	3	1.5
2	ES-CS291	Programming for Problem Solving Laboratory	0	0	3	3	1.5
3	ES-ME292	Engineering Drawing	0	0	3	3	1.5
4	HM-HU291	English Language and Technical Communication Laboratory	0	0	2	2	1
Total Practical / Sessional						**11**	**5.5**
Total Semester						**27**	**21.5**

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For fourth year 4 credits
A student in 1st year has to covers from at least three (03) skills:

1. Computer Programming
2. Soft skill
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SEMESTER – III

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE301	Electrical Circuit Analysis	3	1	0	4	4
2	PC-EE302	Analog Electronics	3	1	0	4	4
3	PC-EE303	Electric Field Theory	3	0	0	3	3
4	PC-EE304	Electrical Machine-I	3	1	0	4	4
5	BS-M301	Mathematics -III	3	1	0	4	4
6	MC-EE301	Indian Constitution	3	0	0	3	0
Total Theory						**22**	**19**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE391	Electric Circuit Theory Laboratory	0	0	2	2	1
2	PC-EE392	Analog Electronics Laboratory	0	0	2	2	1
3	PC-EE394	Electrical Machine-I Laboratory	0	0	2	2	1
4	PC-CS391	Numerical Methods Laboratory	0	0	2	2	1
Total Practical / Sessional						**8**	**4**
Total Semester						**30**	**23**

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For first year 8 credits
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For third year 4 credits
For fourth year 4 credits

SEMESTER – IV

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Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	PC-EE401	ElectricalMachine-II	3	1	0	4	4
	PC-EE402	Digital Electronics	3	0	0	3	3
3	PC-EE403	Electrical and Electronics Measurement	3	1	0	4	4
4	PC-EE404	Control Systems	3	0	0	3	3
5	ES-ME401	Thermal Power Engineering	3	0	0	3	3
6	MC-EE401	Environmental Science	3	0	0	3	0
Total Theory						**20**	**17**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	**T**	**P**		
1	PC-EE491	Electrical Machine-II Laboratory	0	0	2	2	1
2	PC-EE492	Digital Electronics Laboratory	0	0	2	2	1
3	PC-EE493	Electrical and Electronics Measurement Laboratory	0	0	2	2	1
4	PC-EE494	Control Systems Laboratory	0	0	2	2	1
Total Practical /Sessional						**8**	**4**
Total Semester						**28**	**21**

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For second year 4 credits
For third year 4 credits
For fourth year 4 credits

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SEMESTER –V

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	PC-EE501	Power Electronics	3	0	0	3	3
2	PC-EE502	Power System-I	3	0	0	3	3
3	PC-EE503	Microprocessor & Micro Controller	3	0	0	3	3
4	OE-EE501	Open Elective - I	3	0	0	3	3
5	PE-EE501	Professional Elective - I	3	0	0	3	3
6	PE-EE502	Professional Elective - II	3	0	0	3	3
Total Theory						**18**	**18**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	PC-EE591	Power Electronics Laboratory	0	0	2	2	1
2	PC-EE592	Power System-I Laboratory	0	0	2	2	1
3	PC-EE593	Microprocessor &Microcontroller Laboratory	0	0	2	2	1
4	OE-EE591	Open Elective- I Laboratory	0	0	2	2	1
5	SE-EE581	Term Paper and Seminar	0	0	2	2	1
Total Practical / Sessional						**10**	**5**
Total Semester						**28**	**23**

Professional Elective - I		**Professional Elective - II**		**Open Elective - I**	
PE-EE 501A	Digital Signal Processing	PE-EE502A	Advanced Control Systems	OE-EE501A / OE-EE591A	Data Structure and Algorithm/ Data Structure and Algorithm Laboratory
PE-EE 501B	Computational Electromagnetics	PE-EE502B	Machine Dynamics	OE-EE501B / OE-EE591B	Electronic Devices/ Electronic Devices Laboratory
PE-EE 501C	IOT Based Electrical Systems	PE-EE502C	Computer Architecture	OE-EE501C / OE-EE591C	Communication Engineering/Communication Engineering Laboratory

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SEMESTER –VI

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	PC-EE601	Power System - II	3	0	0	3	3
2	PE-EE601	Professional Elective - III	3	0	0	3	3
3	PE-EE602	Professional Elective - IV	3	0	0	3	3
4	OE-EE601	Open Elective - II	3	0	0	3	3
5	OE-EE602	Open Elective - III	3	0	0	3	3
6	HM-EE601	Economics for Engineers	3	0	0	3	3
		Total Theory				**18**	**18**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	PC-EE691	Power System - II Laboratory	0	0	2	2	1
2	PE-EE691	Professional Elective - III Laboratory	0	0	2	2	1
3	PC-EE692	Electrical System Design Laboratory	0	0	6	6	3
4	OE-EE691	Open Elective - II Laboratory	0	0	2	2	1
		Total Practical /Sessional				**12**	**6**
Total Semester						**30**	**24**

Professional Elective - III		**Professional Elective - IV**	
PE-EE601A/ PE-EE691A	Electric Drives/Electric Drives Laboratory	PE-EE602A	High Voltage Engineering
PE-EE601B/ PE-EE691B	Static Control of A.C & D.C Drives / Static Control of A.C & D.C Drives Laboratory	PE-EE602B	Utilization of Electric Power
-	-	PE-EE602C	Mechatronics and Robotics
-	-	PE-EE602D	Electrical and Hybrid Vehicles

Open Elective - II		**Open Elective - III**	
OE-EE601A/ OE-EE691A	Data Base Management System/ Data Base Management System Laboratory	OE-EE602A	Computer Networking
OE-EE601B/ OE-EE691B	Embedded System/ Embedded System Laboratory	OE-EE602B	Artificial Intelligence and Machine Learning
OE-EE601C/ OE-EE691C	Data Analytics with Python/ Data Analytics with Python Laboratory	-	-

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For fourth year 4 credits

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SEMESTER –VII

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	PE-EE701	Professional Elective - V	3	0	0	3	3
2	OE-EE702	Open Elective - IV	3	0	0	3	3
3	HM-EE701	Principle of Management	3	0	0	3	3
		Total Theory				**9**	**9**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	SE-EE781	Internship-I	0	0	0	0	3
2	PR-EE782	Project - I	0	0	8	8	4
Total Practical / Sessional						**8**	**7**
Total Semester						**17**	**16**

Professional Elective - V		**Open Elective - IV**	
PE-EE701A	EHVAC Transmission	OE-EE702A	Power Plant Engineering
PE-EE701B	Electrical Energy Conservation and Auditing	OE-EE702B	Power Plant Instrumentation and Control
PE-EE701C	Power Quality and FACTS	OE-EE702C	Industrial Safety and Management

PE-EE701D	Renewable Energy	-	-

For Honours Course in B. Tech. (As per New guideline of AICTE/MAKAUT), total 20 credits is required over four years in the following way:
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For third year 4 credits
For fourth year 4 credits

SEMESTER –VIII

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	HM-EE801	Organizational Behaviour	2	0	0	2	2
		Total Theory				**2**	**2**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs.	Credits
			L	T	P		
1	SE-EE881	Internship-II	0	0	8	8	4
2	PR-EE882	Project -II	0	0	12	12	6
3	VI-EE883	Comprehensive Viva Voce	-	-	-	0	1
Total Practical / Sessional						**20**	**11**
Total Semester						**22**	**13**

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For third year 4 credits
For fourth year 4 credit

SEMESTER –III

Course Title: Electrical Circuit Analysis

Course Code: PC-EE301	**Category**: Professional Core Courses
Course Title: Electrical Circuit Analysis	**Semester**: 3rd
L-T-P: 3-1-0	**Credit: 3+1**
Pre-Requisites: Basic Electrical Engineering, Engineering Mathematics.	

Course Outcomes:

CO1: State basic terminologies, methods and theorems for solving electric networks.

CO2: Discuss different types of network characterization and explain their significance in modeling of electric circuits.

CO3: Use mathematical tools to solve the equations formulated for modeling electrical networks.

CO4: Analyze the responses of the elementary signals applied to various electrical networks both in time and frequency domain.

Module 1: Introduction (6 hours)
Network analysis & synthesis, Network Characterization, Basic definitions: Continuous & Discrete, Fixed & Time varying, Linear and Nonlinear, Lumped and Distributed, Passive and Active networks and systems. Independent & Dependent sources. Elementary Signals. Characteristics of voltage, current, power and energy signals during charging and discharging of capacitor and inductor. Series and parallel resonance, quality factor, band width, selectivity, half power frequencies.

Module 2: Magnetically Coupled Circuit and Resonance (4 hours)
Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Solution of problems.

Module 3: Application of Laplace Transform and Fourier Method in network analysis (16 hours)
Impulse, Step & Sinusoidal response of RL, RC, and RLC circuits, initial and final conditions in network elements, forced and free response, time constants. Steady state and Transient analysis of different electrical circuits. Concept of Convolution theorem and its application.
Solution of Problems with DC & AC sources.
Application of Fourier series and Fourier transform for analyzing the waveform of different signals observed in electric circuits.

Module 4: Network Theorem (8 hours)
Formulation of network equations, Source transformation, Loop variable analysis and Node variable

analysis (including Super mesh and Supernode concept). Network theorem: Superposition, Thevenin's, Norton's & Maximum power transfer theorem. Millman's theorem, Tellegen's theorem, Reciprocity Theorem, Compensation theorem and their applications.
Module 5: Two Port Networks (6 hours) Open circuit Impedance & Short circuit Admittance parameter, Transmission parameters, Hybrid parameters and their inter relations. Driving point impedance & Admittance. Solution of Problems
Module 6: Active Filter Circuits (4 hours) Analysis and synthesis of Low pass, High pass, Bandpass, Band reject, All pass filters (first and second order only) using operational amplifiers. Solution of Problems
Module 7: Graph theory and Networks equations (4 hours) Graph, Tree and link branches, Network matrices and their relations, Choice of linearly independent network variables, Topological equations for loop current and for nodal voltage, Duality.
Solution of Problems with independent and dependent DC and AC sources.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	-	-	2	-	-	1	2	3
CO 2	3	3	2	2	3	-	1	-	-	-	2	3
CO 3	3	3	2	2	3	-	1	-	-	-	2	3
CO 4	3	3	2	2	-	-	2	-	-	-	1	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	2
CO 2	3	3	2
CO 3	3	3	2
CO 4	3	2	2

Text Books:

1. Network Analysis & Synthesis, S. P. Ghosh, A. K. Chakraborty, McGraw Hill publisher.
2. Network Analysis & Synthesis, Ravish R. Singh, McGraw Hill Education (India) Pvt. Ltd.
3. Networks and Systems, D. Roy Chowdhury, New Age InternationalPublishers.
4. Circuit theory, Dr. AbhijitChakrabarty, DhanpatRai& Co Pvt. Ltd.

Reference Books:

1. Fundamentals of Electric Circuits, Charles K. Alexander, Matthew N. O. Sadiku, McGraw Hill.

2. Introductory Circuit Analysis, Robert L. Boylestad, Pearson.
3. Network Analysis, M.E. Valkenburg, Pearson Education.
4. Engineering Circuit Analysis, W.H. Hyat, J.E. Kemmerly & S.M. Durbin, The McGraw Hill Company.
5. Electric Circuits and Networks, K. S. Suresh Kumar, Pearson.

Course Title: Analog Electronics

Course Code: PC-EE302	**Category**: Professional Core Courses
Course Title: Analog Electronics	**Semester**: 3rd
L-T-P:3-1-0	**Credit: 3+1**
Pre-Requisites: Basic Electronics, Semiconductor Physics.	
Course Outcomes:	
CO1: Remember the fundamental principles and behaviors of semiconductor devices such as diodes and transistors.	
CO2: Understand the terminal characteristics of semiconductor devices and their applications in electronic circuits, and explain the principles behind amplifier circuits, encompassing load lines, quiescent points, and small signal operations.	
CO3: Apply various biasing techniques to semiconductor devices to achieve desired circuit functionality.	
CO4: Analyze the terminal characteristics of semiconductor devices to predict their behaviour in different circuit configurations.	
Module 1: Application of Diodes and BJT(10 hours) Applications of diodes: rectifier circuits, clipping and clamping circuits. Special purpose diodes: Zener diodes, LED, tunnel diodes and varactor diodes. Transistor: Different transistor connections and their terminal characteristics, Concept of load line and quiescent point, Biasing of transistors and study of various biasing circuits, Bipolar Transistor amplifier circuits, small signal operations of BJT.	
Module 2: Multi-staging and Power amplifiers (8 hours) Role of capacitors in multistage amplifiers, Capacitively coupled amplifiers, Transformer coupled amplifiers, Direct coupled amplifiers, class A power Amplifiers, class B power Amplifiers, class C and D power Amplifiers.	

Module 3: Field Effect Transistors (8 hours)
Types of field effect transistors, Principle and working of JFET, biasing the junction FET, JFET amplifier, MOSFET characteristics and biasing, small and high frequency equivalent circuits and parameters, linear amplifiers.

Module 4: OPAMP (10 hours)
Ideal Op-amp, Differential amplifier: differential and common mode operations, Performance parameters of Op-amp, Practical op-amp circuits: inverting amplifier, non-inverting amplifier, weighted summer, integrator and differentiator.

Module 5: Application of Op-amp and Oscillators (12 hours)
Waveform generators, Schmitt Trigger, Comparators, Instrumentation Amplifier, Logarithmic amplifiers, Active filters. Oscillators: condition for oscillation, phase shift. Different oscillator types: Wien Bridge, Hartley, Colpitts and crystal oscillators

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	3	2	2	-	-	-	3	3
CO 2	3	3	2	3	2	2	2	-	-	-	3	3
CO 3	3	2	2	2	2	2	2	2	2	2	3	3
CO 4	3	3	3	3	3	3	2	2	2	2	3	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	2
CO 2	1	3	3
CO 3	-	3	3
CO 4	2	3	3

Text Books:

1. Analog Electronics, L.K Maheshwari, MM.S Anand, PHI Publication.
2. Analog and Digital Electronics, Sanjay Agrawal, Sonveer Singh, Wiley PublicationCompany.

Reference Books:

1. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press,1989.
2. P. R. Gray, R. G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.
3. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press,1998.
4. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education,1988.

Course Title: Electric Field Theory

Course Code: PC-EE303	**Category**: Professional Core Courses
Course Title: Electric Field Theory	**Semester**: 3rd
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical Engineering, Mathematics and Physics.	

Course Outcomes:

CO1:Identify between several coordinate system types and applying them to the resolution of electromagnetic field theory issues.

CO2: Understand electromagnetic potentials, boundary conditions, related laws, and the behaviour of static electric and magnetic fields in various mediums.

CO3: Apply the integral and point forms of Maxwell's equations to solve electromagnetic field theory problems.

CO4: Analyze time-varying fields, the propagation of electromagnetic waves in various media, the Poynting Theorem, their causes, and their consequences, as well as applying the theory of electromagnetic waves to solve real-world issues.

Module 1: Review of Vector Calculus (6 hours)
Introduction: Co-ordinate systems and transformation, Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different co-ordinate system.
Introduction to Vector calculus: Gradient, Divergence and curl operation and applications. Divergence theorem and Stoke's Theorem. Laplacian operator on scalar and vector, Classification of vector fields, Statement of Helmholtz's theorem, Uniqueness theorem.

Module 2: Static Electric Field (6 Hours)
Coulomb's law, Electric field intensity: Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications.
Energy and potential: Absolute Electric potential, Potential difference, Relationship between E and V, Polarization and Dipole moment, Electrostatic Energy and Energy density.

Module 3: Conductors, Dielectrics and Capacitance (4 Hours)
Current and current density, Continuity equation, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two-wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Module 4: Static Magnetic Fields (4 Hours)
Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Module 5: Magnetic Forces, Materials and Inductance (4Hours)
Force on a moving charge and current carrying conductor due to magnetic field, Torque developed in current carrying coil in a magnetic field, magnetic moments, forces on magnetic material, Magnetization in material, Magnetic boundary condition, Inductor and Inductances, Magnetic energy

Module 6: Time Varying Fields and Maxwell's Equations (6 Hours)
Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Transformer and Motional Electromotive forces. Time varying Potential and Time Harmonic Field.

Module 7: Electromagnetic Waves (6 Hours)
Electromagnetic wave equation in loss-less dielectric medium and conducting medium, Plane and polarized waves and their propagation, Pointing vector, Reflection and Refraction in plane wave and normal and oblique incidence. Standing-Wave Ratio, Skin effect, Skin depth.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	-	3	2	2	3	2	2	2
CO2	2	2	2	2	3	3	2	2	3	3	2	3
CO3	2	2	2	2	2	3	2	2	2	3	2	3
CO4	3	2	2	2	2	3	2	1	2	1	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	2	2	2
CO3	1	2	2
CO4	2	3	2

Text Books:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication,2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd,

New Delhi,2009.
3. Engineering Electromagnetics by W.H. Hayt.
4. Electromagnetic field theory fundamentals, Guru &Hizroglu, 2nd edition, Cambridge University.

Reference Books:

1. Electromagnetic fields byGriffiths.
2. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans,1954.
3. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication,1980.
4. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields,3rd,TMH, 2011.

Course Title: Electrical Machine-I

Course Code: PC-EE304	**Category**: Professional Core Courses
Course Title: Electrical Machine-I	**Semester**: 3rd
L-T-P:3-1-0	**Credit: 3+1**
Prerequisites: Higher Secondary Level Physics, Mathematics and Basic Electrical Engg.	
Course Outcomes:	
CO1: Recallthe conceptsof trigonometry, complex algebra, phasor operations and principles of Electro-magnetism related to DC machines, Transformer and three phase induction motor.	
CO2: Understand the working principles of electrical machines, devices and discuss their construction.	
CO3: Construct emf equation, torque equation and different equivalent circuits of different electrical machines and devices.	
CO4: Analyze and plot relevant characteristics of DC machine and transformer to correctly predict the expected performance.	
Module 1: Magnetic Field, Magnetic Circuits, Electromagnetic Force and Torque (8 hours) Review of magnetic Circuit: MMF, flux, reluctance, influence of highly permeable materials on the magnetic flux lines. Electromechanical Energy Conversion Principle, Singly Excited Magnetic System Doubly Excited Magnetic system. B-H Curve of magnetic materials, flux-linkage vs current characteristic of magnetic circuits; Physical concept of torque production, Electromagnetic torque and Reluctance torque.	

Module 2: DC Machine (10 hours)
Basic construction of DC machine, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Module 3: DC Machine motoring and generation (10 hours)
Field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines.

Module 4: Three Phase Transformers (10 hours)
Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, applications and comparison with two winding transformer, Magnetizing current, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Module 5: Three Phase Induction Motor (10 hours)
Induction motor as a Transformer, Flux and MMF phasors in Induction motors, Equivalent circuit, Performance equations, Induction motor phasor diagram, Toque-slip characteristic, Power slip characteristic, Determination of equivalent circuit parameters. Methods of starting of squirrel Cage and Wound Rotor Motors. Speed control of Induction motor, Polarity Test, Application of Polyphase Induction motor.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	2	2	2	2		1	2	2	2
CO 2	3	2	2	3	2	2	2	2	1	1	2	2
CO 3	3	2	3	3	3	2	2	2	1	2	2	2
CO 4	3	3	2	2	2	2	3	2	2	3	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	2
CO 2	2	3	3
CO 3	2	2	2
CO 4	3	2	2

Text Books:

1. Electrical Machines: Theory and Practice, M. N. Bandyopadhyay, PHI Learning Pvt. Ltd.
2. Electrical Machines, P. Purkait and I. Bandyopadhyay,Oxford.
3. Electrical Machinery, P.S. Bimbhra, 7th Edition, Khanna Publishers.
4. Electrical Machines, P.K. Mukherjee & S. Chakrabarty, 2nd edition, Dhanpat Rai Publication.

Reference Books:

1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K. Srivastava, Cengage Learning.
3. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition.
4. The performance and Design of Alternating Current Machines, M.G.Say, CBS. Publishers & Distributors.
5. Electric Machinery & transformer, Irving L Koskow, 2nd Edition, Prentice Hall India.

Course Title: Mathematics-III

Course Code: BS-M301	**Category**: Basic Science Courses
Course Title: Mathematics-III	**Semester**: 3rd
L-T-P: 3-1-0	**Credit: 3+1**
Course Code: BS-M301	
Prerequisites: Basics of Mathematics.	
Course Outcomes:	
CO1: Recall the earlier mathematical thoughts, such as idea of sets, permutation, combination, number system, graphs, sequence, series and integral calculus.	
CO2: Exhibit the idea of preliminaries on probability, recognize the concept of Fourier series, statistics, numerical methods and integral transform.	
CO3: Apply the knowledge of probability, data statistics, numerical methods and Fourier transform to solve real life engineering problems.	
CO4: Justify and make gradation of above-mentioned mathematical tools and determine the right approach to solve multidisciplinary engineering problems.	
Module-1: Fundamentals of Probability [12 Hours] Independent events, Conditional Probability. Bayes' Theorem and its applications. Probability distributions: Random Variables – Discrete and Continuous, Probability Mass Function, Probability Density and Cumulative Distribution Functions, Mathematical Expectation and Variance. Special Distributions: Binomial, Poisson, Uniform, Exponential and Normal. Chebychef's inequality.	
Module-2: Data statistics [8 Hours] Basic Statistics, Measures of Central tendency, Measures of dispersions, Moments, skewness and Kurtosis - Correlation and regression – Rank correlation. Curve fitting by the method of least	

squares- fitting of straight lines, second degree parabolas and more general curves.

Module-3: Fourier Series [8 Hours]

Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave.
Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π, Fourier Series for functions of period $2l$, Dirichlet's conditions, Sum of Fourier series.

Theorem for the convergence of Fourier Series (statement only). Fourier Series of a function with its periodic extension. Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series. Parseval's identity (statement only).

Module-4: Fourier Transform [8 Hours]

Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier, Fourier Cosine & Sine Transforms of elementary functions. Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples. Fourier Transform of Derivatives. Convolution Theorem (statement only), Inverse of Fourier Transform.

Module-5: Numerical Methods-I [4 Hours]

Error & Interpolation: Approximation in numerical computation and Interpolation: Truncation and rounding errors, Fixed and floating-point arithmetic. Calculus of finite differences, Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.

Module-6:Numerical Methods-II [8 Hours]

Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms. Numerical solution of nonlinear equation: Bisection method, Regula-Falsi method, Newton-Raphson method.
Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	3	-	1	-	-	-	-	-	-	2
CO 2	3	-	-	1	-	-	-	-	-	-	-	2
CO 3	3	-	2	3	-	-	-	-	-	-	-	2
CO 4	3	3	-	3	-	-	-	-	-	1	-	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	-
CO 2	2	-	-
CO 3	3	-	-
CO 4	3	-	1

Text Books:

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
4. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.

References Books:

1. Murray R Spiegel, Larry J. Stephens, Narinder Kumar. Statistics (Schaum's Outline Series), McGraw Hill Education.
2. N.G. Das, Statistical Methods (Combined Volume), Tata-McGraw Hill.
3. Gupta & Kapoor, Fundamentals of Mathematical Statistics, Gupta (Sultan Chand &Sons).
4. K. Sankara Rao, Introduction to Partial Differential Equations, PHI Learning Pvt. Ltd.
5. S. Ponnusamy, Foundations of Complex Analysis, Narosa.
6. Jain, Iyengar& Jain: Numerical Methods (Problems and Solution).

Course Title: Indian Constitution

Course Code: MC-EE301	**Category**: Mandatory Courses
Course Title: Indian Constitution	**Semester**: 3rd
L-T-P: 3-0-0	**Credit: 0**
Pre-Requisites: Nil	
Course Outcomes:	
CO1: Acquire the concept of preamble of Indian Constitutions including fundamental rights & duties and directive principles.	
CO2: Describe the roles of Governor, Chief Minister, Prime Minister, President, Council of Ministers, Cabinet, Secretariat in the context of Indian Constitution.	
CO3: Analyse the structure, jurisdiction, legal importance and function of Supreme Court, High Court, Subordinate Court &PIL.	
CO4: Analyse the State-Central policies, Electoral Process and functions of local administration starting from Panchayats Level to Municipal Corporation.	
Module 1: Indian Constitution (6 hours) Source and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.	
Module 2: Union government and its Administration, State Government and its Administration(10 Hours) Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and	

position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha.
Governor role and position, CM and Council of Ministers, State Secretariat: Organization, Structure and Functions.

Module 3: Court (10 Hours)

Supreme court: Organization of supreme court, procedure of the court, independence of the court, jurisdiction and power of supreme court.
High court: Organization of high court, procedure of the court, independence of the court, jurisdiction and power of supreme court.
Subordinate courts: constitutional provision, structure and jurisdiction. National legal services authority, Lok adalats, family courts, gramnyayalays.
Public interest litigation (PIL): meaning of PIL, features ofPIL, scope of PIL, principle of PIL, guidelines for admittingPIL.

Module 4: Local Administration (10 Hours)

District's Administration head: Role and Importance,Municipalities: Introduction, Mayor and role of ElectedRepresentative, CEO of Municipal Corporation,
Panchayati raj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role
Block level:Organizational Hierarchy (Different departments)
Village level: Role of Elected and Appointed officials, Importance ofgrass root democracy.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	-	-	-	-	-	3	-	3	-	-	-	-
CO 2	-	-	-	-	-	3	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	-	2	-	-	-	-
CO 4	-	-	-	-	-	3	-	1	-	-	-	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	-	-	3
CO 2	-	-	2
CO 3	-	-	3
CO 4	-	-	2

Text books:

1. Indian polity, M, Laxmikanth, MCGraw Hill education, 5th Edition.

Reference books:

1. DD Basu, "Introduction to the constitution of India", 21st Edition, Lexis Nexis Books Publication ltd, India.

Course Title: Electrical Circuit Theory Laboratory

Course Code: PC-EE391	**Category**: Professional Core Courses
Course Title: Electrical Circuit Theory Laboratory	**Semester**: 3rd
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Basic Electrical Engineering (Theory and Laboratory).	

Course Outcomes:

CO1: Remember the theoretical knowledge of different mathematical tools and define theorems used in network analysis.

CO2: Understand electrical components and discuss basic use of software tools for electric network analysis.

CO3: Practice experimental circuits both in software and hardware.

CO4: Examine experimental results and compare with theoretical concepts.

Experiments Title:

1. Introduction to MATLAB: Basic matrix operation, file operations, plotting, MATLAB program development in the command window.
2. Generation of Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, ramp signal using MATLAB in both discrete and analog form.
3. Determination of Laplace transform and Inverse Laplace transform using MATLAB.
4. Transient response of R-L and R-C network: simulation with software & hardware
5. Transient response of R-L-C series and parallel circuit: simulation with software & hardware
6. Amplitude and Phase spectrum analysis of different signals: Simulation with software
7. Verification of Network theorems using software & hardware
8. Determination of Impedance (Z) and Admittance (Y) parameter of two-port network: Simulation & hardware.

9. Frequency response of LP and HP filters: simulation & hardware.
10. Frequency response of BP and BR filters: simulation & hardware.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	3	3	2	2	-	3	1	3	3
CO 2	3	3	3	3	3	2	2	-	3	1	3	3
CO 3	3	3	3	3	3	2	2	-	3	1	3	3
CO 4	3	3	3	3	3	2	2	-	3	1	3	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	2
CO 2	1	3	3
CO 3	1	3	3
CO 4	2	3	3

Course Title: Analog Electronics Circuit Laboratory

Course Code: PC-EE392	**Category**: Professional Core Courses
Course Title: Analog Electronics Laboratory	**Semester**: 3rd
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Basic Electronics, Semiconductor Physics.	
Course Outcomes:	
CO1: Recall the fundamental principles and concepts related to semiconductor devices and electronic circuits.	
CO2: Demonstrate understanding of the operating principles behind the behaviour of Zener diodes, BJTs, JFETs, and diode rectifiers.	
CO3: Apply measurement techniques to plot forward and reverse IV characteristics of a silicon diode and apply knowledge of Zener diodes to design and demonstrate a simple voltage regulator circuit.	

CO4: Analyze the input and output characteristics of a BJT in a common emitter configuration while comparing and contrasting amplifier classes such as Class A and Class C.

Perform 10 experiments from the following:

1. Measure and plot the forward and reverse IV characteristics of a silicon diode and measure the dc and ac(dynamic)resistance of the diode.
2. Study and demonstrate the characteristics of a Zener diode and its use as a simple voltage Regulator.
3. Determine the input and output and output characteristics of a bipolar junction transistor (BJT) in a common emitter configuration and measure its h-parameter at a given point.
4. To demonstrate the dc operating point for transistor fixed bias circuit and voltage bias circuit and compare their bias stabilities against changes in the transistor beta.
5. Determine and sketch the characteristics of JFET and find its parameters.
6. Study of ripple and regulation characteristics of full wave diode rectifier with and without filter
7. Study of class A power amplifier.
8. Study of class C power amplifier.
9. Construction of two stages R-C coupled amplifier and studying its gain and bandwidth.
10. Development of diode clipping and clamping circuits and analyze their outputs with different analog inputs.
11. Design op-amp based differentiator and integrator and observe its response with different analog inputs.
12. Develop an RC phase shift oscillator for 1 kHz and measure the frequency of oscillation and plot its output waveform.
13. Study of ripple and regulation characteristics of half wave diode rectifier with and without filter.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	3	2	2	-	-	-	3	3
CO 2	3	3	3	3	3	3	2	3	3	3	3	3
CO 3	3	3	3	3	3	3	2	3	3	3	3	3
CO 4	3	3	3	3	3	3	2	3	3	3	3	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	2
CO 2	1	3	3
CO 3	1	3	3
CO 4	2	3	3

Course Title: Electric Machine-I Laboratory

Course Code: PC-EE394	**Category**: Professional Core Courses
Course Title: Electrical Machine-I Laboratory	**Semester**: 3rd
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: Physics (Theory and Laboratory), Circuit Theory, Basic Electrical Engg. (Lab and Theory).	
Course Outcomes:	
CO1:Recallrelevant concepts of Electric Machine-I course.	
CO2: Understand the working principles of electrical machines, devices to Set up testing strategies and select proper instruments to evaluate performance characteristics.	
CO3: Practice different types of wiring and devices connections keeping in mind technical, economical, safety issues.	
CO4: Analyze and evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.	

Choose 10 experiments from the following:

1. Determination of the characteristics of a separately excited DC generator.
2. Determination of the characteristics of a DC motor.
3. Study of methods of speed control of DC motor.
4. Determination of the characteristics of a compound DC generator (short-shunt).
5. Determination of speed of DC series motor as a function of load torque.
6. Polarity test and study of parallel operation on single phase transformers.
7. Determination of equivalent circuit parameters of a single-phase transformer and efficiency.
8. Study of different connections of three phase transformers.
9. Different method of starting of 3 phase squirrel cage Induction motor & their comparison [D.O.L, Auto transformer & Star-Delta].
10. Speed control of 3 phase squirrel cage induction motor by different methods & their comparison. [voltage control & frequency control]
11. Speed control of three phase slip ring Induction motor by rotor resistance control.

CO & PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	1	2	2	2	2	-	2	-	-	-
CO 2	3	2	2	3	2	2	2	2	-	2	2	2
CO 3	3	2	3	3	3	2	2	-	2	2	2	2
CO 4	3	3	2	2	2	2	3	2	2	3	2	2

CO & PSO Mapping:

	PSO1	**PSO2**	**PSO3**
CO 1	3	2	2
CO 2	3	2	2
CO 3	3	3	2
CO 4	3	2	2

Course Title: Numerical Methods Laboratory

Course Code: **ES-CS391**	**Category**: Engineering Science
Course Title: **Numerical Methods Laboratory**	**Semester**: 3rd
L-T-P:0-0-2	**Credit: 1**

Course Outcomes:
CO1: Recalling the basic programming tools such as, variable declarations, array in one and two dimensions, for-loop, nested for-loop, if-else and repeated summation & multiplication.
CO2: Describe how to write down a program. Explain the logic behind the different numerical tools.
CO3: Use a different programming language to write the program for interpolation, integration, algebraic equations, system of linear equations and boundary value differential equations for large number of data and complicated functions.
CO4: Analyze different real time problems and categorize them during the process of solving, by numerical method using programming language.

Experiments Title:

1. Assignments on Newton forward /backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
4. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton-Raphson methods.
5. Assignments on ordinary differential equation: Euler's and Runga-Kutta methods.
6. Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	3	2	3	-	-	-	-	-	-	1
CO 2	2	2	2	2	2	-	-	-	1	-	-	1
CO 3	3	3	3	3	3	-	-	-	-	-	-	-
CO 4	3	3	2	3	2	-	-	-	1	-	-	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	-
CO 2	2	2	-
CO 3	3	3	-
CO 4	3	2	-

SEMESTER –IV

Course Title: Electrical Machines-II

Course Code: PC-EE401	**Category**: Professional Core Courses
Course Title: Electrical Machines-II	**Semester**: 4th
L-T-P: 3-1-0	**Credit: 3+1**
Pre-Requisites: Physics, Mathematics, Basic Electrical Engineering and Electrical Machines-I.	
Course Outcomes:	
CO1: Recall the mathematical operations and electromagnetic principles of electrical machines.	
CO2: Interpret working and operations of electrical machines based on basic principles.	
CO3: Develop mathematical equations for different electrical quantities and parameters for electrical machine operations.	
CO4: Inspect different characteristics of electrical machines and analyze their performances.	
Module 1: Single phase Induction motor (12 hours) Construction, Double revolving field theory, Cross field theory, Starting methods, Speed —Torque characteristics, Phasor diagram, condition of maximum torque, Determination of equivalent circuit parameters, Applications. Single Phase AC series motors, compensated and uncompensated motors.	
Module 2: Synchronous Machines (20 hours) Constructional features, types, excitation systems, generator & motor modes, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation (EMF, MMF, ZPF). Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics.	

Parallel operation of alternators - synchronization and load division. Synchronous machine connected to infinite bus, effect of change of excitation and speed of prime mover. Starting of Synchronous Motor, V- Curve, damper winding, hunting.

Module 3: Special Electromechanical devices (16 hours)

Principle and construction of switched Reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper motor, Tacho-generators, Synchro & resolvers. AC servo motors. Principle, construction and operational characteristics of Induction generator & linear Induction motor.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	-	-	-	-	-	-	-	1
CO 2	3	3	3	2	2	-	-	-	-	-	-	2
CO 3	3	3	3	3	3	-	-	-	-	-	-	3
CO 4	3	3	2	3	2	-	-	-	-	-	-	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	-	3	2
CO 2	1	2	3
CO 3	2	3	3
CO 4	3	2	2

Text Books:

1. Electrical Machinery, P.S. Bhimra, Khanna Publishers.
2. Generalized Theory of Machine- P.S. Bimbhra, Khanna Publishers.
3. Electrical Machines -Nagrath &Kothary,TMH.
4. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI.
5. Mukherjee P K & Chakraborty S, Electrical Machines; Dhanpat Rai Pub.

Reference Books:

1. Electric Machinery & Transformer, Bhag S. Guru and H.R. Hiziroglu, 3rdEdition, Oxford U university press.
2. Performance & Design of A.C. Machines — M.G. Say, CBS Publishers.
3. Electric Machinery &Transformers, Irving L. Kosow, PHI.
4. Electric Machinery, A.E. Fitzgerald, Charles Kingsley, Jr. & Stephen D. Umans, 6th Edition, Tata

McGraw Hill Edition.

5. Electrical Machines, R.K. Srivastava, Cengage Learning.
6. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition.
7. The performance and Design of Alternating Current Machines, M.G. Say, CBS publishers & distributors.
8. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.
9. Electric Machines, Charles A. Gross, CRC press.

Course Title: Digital Electronics

Course Code: PC-EE402	**Category**: Professional Core Courses
Course Title: Digital Electronics	**Semester**: 4th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic concepts of number system, Basic concept of electronic circuits, Basic knowledge of circuit theory.	
Course Outcomes:	
CO1: Remember with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from to others.	
CO2: Understand Learn the minimization techniques to simply the hardware requirements of digital circuits, implement it, design and apply for real time digital systems.	
CO3: Apply the working mechanism and design guidelines of different combinational, sequential circuits and their role in the digital system design.	
CO4: Examine different types of with or without memory based digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraint.	
Module 1:Data and Number System (10 hours) Binary, Octal and Hexadecimal representation and their conversion, BCD, ASCII, EBCDIC, Gray codes and their conversion, Signed binary numbers representation with 1's and 2's complement methods, Binary arithmetic(addition, subtraction, multiplication, division), sign-magnitude binary representation. Error detecting and correcting codes, **Boolean Algebra** Various logic gates and their truth tables and circuits, Representation in SOP and POS forms, Minimization of logic expressions by algebraic method, K-map method. Q-M method of function realization	

Module 2: Combinational Circuits (6 hours)
Adder and subtractor circuit, Circuit of Encoder, Decoder, Comparator, Multiplexer, Demultiplexer, Parity Checker & Generator, Parity Encoder. Static and dynamic hazards for combinational logic.

Module 3: Sequential Circuits (8 hours)
Flip-Flop: Basic memory elements, S-R, J-K, D, and T Flip-flop,
Register: Various types of Registers & their design.
Counter: Counters & their design, Irregular counter, State table & State transition diagram, Sequential circuit design methodology.

Module 4: A/D and D/A Converters (6 hours)
Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.

Module 5: Memory Systems - RAM, ROM, EPROM, EEPROM, Logic Families(6 hours)
Characteristics of digital ICs, TTL, Schottky TTL, ECL, MOS & CMOS, interfacing CMOS and TTL, Tri-state logic, their operation and specification. Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Combinational PLD-Based State Machines (CPLDS), Field Programmable Gate Array (FPGA).

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	3					2		2
CO 2	3	3	3	3	2	2	2		2		2	
CO 3	3	3	2	2	2	2	2	2				
CO 4	3	3	2	2	2	3	2	2	2		2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	3
CO 2	3	2	2
CO 3	3	2	3
CO 4	2	3	2

Text Books:

1. Fundamentals of Digital Circuits, A. Anand Kumar, PHI.
2. Modern Digital Electronics, 2nd Edition, R.P. Jain. Tata Mc Graw Hill Company Limited.

Reference Books:

1. Digital Logic Design, Morries Mano, PHI.
2. Digital Principles & Application, 5th Edition, Leach &Malvino, Mc Graw Hill Company.

Course Title: Electrical and Electronics Measurement

Course Code: PC-EE403	**Category**: Professional Core Courses
Course Title: Electrical and Electronics Measurement	**Semester**: 4th
L-T-P: 3-1-0	**Credit: 3+1**
Pre-Requisites: Basic Electrical Engineering, Electric Circuit Theory, Electromagnetism	
Course Outcomes:	
CO1: Remember the operating logic theoretically and mathematically of different electrical and electronic measuring instruments.	
CO2: Interpret accepted standards and guidelines for the appropriate measuring instruments to meet specified performance requirements.	
CO3: Apply the proper type of measuring procedures and measuring instruments for different industrial/commercial/domestic applications.	
CO4: Analyzedifferent characteristics and performances of measuring instruments.	
Module 1: Introduction of Measurement (4 Hours) Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments.	
Module 2: Analog Meter (8 Hours) General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments, Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multipliers.	
Module 3: Instrument Transformer (6 Hours) Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of Current & Potential transformer, errors.	

Module 4: Measurement of Power, Energy and Power Factor (8 Hours)
Power: Construction, Theory and principle of operation of electrodynamometer, electrostatic Wattmeter, Measurement of 1φ and 3 φ power by Wattmeter.
Energy: Construction, Theory and principle of operation of 1φ Induction watt-hour meter, Errors and compensation, working principle of digital energy mete
Theory and operation of frequency, power-factor meters, calibration of Wattmeters and Energy meters.

Module 5: Oscilloscope (4 Hours)
CRO, Block diagram, sweep circuits, Delay line, multiple trace, and oscilloscope probes. Measurement of voltage, current, frequency & phase by oscilloscope, Frequency limitation of CRO. Double beam CRO. Sampling and storage oscilloscope.

Module 6: Measurement of Resistance, Inductance, Capacitance and Frequency (6 Hours)
Measurement of medium, low and high resistances, Megger.
Potentiometer:DC Potentiometer: Construction, theory and Principle of Basic slide wire DC potentiometer, Crompton and Vernier potentiometers. Brief idea on AC potentiometers.
AC Bridge: Measurement of Inductance, Capacitance and frequency by AC bridges.

Module 7: Electronic Instruments for measurement of basic parameters: (6 Hours)
Introduction, Electronic DC & AC Voltmeters, True RMS Voltmeter, Peak response Voltmeter, Q-meter, Digital Voltmeters. Advantages of digital meter over analog meters, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator, Digital Storage oscilloscope.

Module 8: Sensors & Transducers (6 Hours)
Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Flow measurement using magnetic flow measurement.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	1	-	-	-	-	1	-	1
CO 2	3	3	2	3	2	2	2	-	1	-	2	2
CO 3	3	3	2	2	2	2	2	1	1	-	1	2
CO 4	2	3	2	2	2	3	2	1	1	-	1	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	2
CO 2	3	3	2
CO 3	2	3	3
CO 4	2	3	2

Text Books:

1. A course in Electrical & Electronic Measurements & Instrumentation, A.K.Sawhney, Dhanpat Rai &sons.
2. Electrical Measurement & Measuring Instruments, E.W. Golding &F.C. Wides, Wheeler Publishing.
3. Modern Electronic Instrumentation and Measurement Techniques, Helfrick & Cooper, 2nd Edition. PHI.

Reference Books:

1. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.
2. Electronic Instrumentation & Measurements, David A. Bell, 3rd Edition, Oxford University press.
3. Instrument transducers, H.K.P. Neubert, Oxford University press.

Course Title: Control System

Course Code: PC-EE404	**Category**: Professional Core Courses
Course Title: Control Systems	**Semester**: 4th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Physics, Mathematics and Circuit Theory.	
Course Outcomes:	
CO1: Recall the mathematical operations and find transfer function models of electrical, and mechanical systems. **CO2**: Interpret the behavior of the system under time domain approach using graphical methods. **CO3**: Apply graphical methods to study the behavior and stability of a system in the frequency domain. **CO4**: Analyze the different control laws and study the performances of proportional control, proportional plus derivative (PD) control, proportional plus integration (PI) control.	

Module 1: Introduction to control system (6 hours)

Elementary control concepts: Types of control systems. Open loop & closed loop systems. Concept of feedback and automatic control. Examples of feedback control systems. Classification of feedback control system. Effects of feedback. Elementary concepts of sensitivity and robustness. Transfer function concept. Pole and Zeros of a transfer function. Properties of Transfer function.

Mathematical modeling of physical systems: Electrical systems. Mechanical Systems, Electromechanical Systems. Block diagram Representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. Analogous System.

Control system elements: Servomechanism and regulator, Potentiometer, DC & AC Techo-generator, examples of feedback control system.

Module 2: Time Domain Analysis (10 hours)

Standard test signals. Time response of first and second order systems for standard test inputs. Time response specifications. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Effects of Pole and Zeros on transient response.

Error Analysis: Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants. Performance error coefficients/Performance indices.

Concept of Stability: Definition and Classifications. Stability by pole location. Routh-Hurwitz criteria and applications. Relative Stability analysis. Root-Locus technique. Construction of Root-loci. Effects of gain on the movement of Pole and Zeros.

Module 3: Frequency Response Analysis (8 hours)

Relationship between time and frequency response, Bode plots. Polar plots, Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Determination of margins from Bode plot. Closed-loop frequency response.

Nichol's chart, M-circle and M-Contours in Nichol

Module 4: Introduction to classical Controller and Compensation Techniques (8 hours)

Preliminary considerations of classical design, Concept of P, PI, PD and PID controllers, Controller design. Tuning controllers: Both closed and open loop methods (Ziegler-Nichols, Cohen, PRC method).

Improvement of system performance through compensation. Lead and Lag compensation in designs. Design specifications in frequency-domain. Frequency-domain methods of design.

Module 5: State Variable Analysis: (4 hours)

Concepts of state variables, State space model, Diagonalization of State Matrix, Solution of state equations, Eigenvalues and Eigenvectors.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	1	1	2	1	2	1	2	1	1
CO 2	2	3	2	2	1	2	1	1	1	1	2	2
CO 3	3	3	2	2	3	1	1	1	2	2	1	2
CO 4	2	3	2	2	2	2	3	1	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	2	2
CO 3	2	2	1
CO 4	2	1	2

Text Books:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill,1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition,1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition,1991.
4. Nagrath I. J. and Gopal M.,"Control Systems Engineering", New Age International (P)Ltd.
5. Nonlinear Systems – H. K. Khalil, Pearson Education

Reference Books:

1. Norman S. Nise, Control Systems Engineering, 4th edition, New York, John Wiley, 2003. (Indian edition)
2. Advance Electrical Technology, H.Cotton, Reem Publication
3. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill,1995.
4. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub,1994
5. Nonlinear Control system, J.E. Gibson, Mc Graw Hill Book Co.
6. Nonlinear System Analysis – M. Vidyasagar, Prentice Hall.
7. Modern Control system, R.C. Dorf & R.H. Bishop, Pearson Education.

Course Title: Thermal Power Engineering

Course Code: ES-ME401	**Category**: Engineering Science Courses
Course Title: Thermal Power Engineering	**Semester**: 4th
L-T-P :3-0-0	**Credit: 3**
Pre-Requisites: Physics.	
Course Outcomes:	

CO1: Describe the function of different components of boilers. Engines and turbines.
CO2: Explain the principle of operation of different types of boilers, turbines, IC engines and Gas turbines.
CO3: Solve numerical problems of boilers, turbines, IC engines and Gas turbines.
CO4: Evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.
Module 1: Boilers (12 Hours) Water Tube & Fire Tube boilers, Circulating Principles, Forced Circulation, Critical pressure, Super heaters, Re-heaters, attemperators, induced draught, forced draught and secondary air Fans, Boiler performance analysis and heat balance. Combustion Systems, Environmental Protection – ESP, Cyclone Separator, Dust Collector etc.
Module 2: Turbines (12 Hours) Turbines: Rotary Thermodynamic devices – Steam turbines & their classifications – Impulse & Reaction type Turbines, Thermodynamics of compressible fluid-flow, equation and continuity – Isentropic flow through nozzles, velocity diagram, Blade efficiency, optimum velocity ratio, multi-staging, velocity & pressure compounding, losses in turbines, erosion of turbine blades,turbine governing, performance analysis of turbine, Condensing system.
Module 3: IC Engines (6 Hours) IC Engines – classification, Analysis of a standard cycle, fuel characteristic of SI & CI Engine, Combustion, Engine performance Automotive Engine exhaust emission and their control
Module 4:Gas Turbines (6 Hours) Gas turbine Analysis – Regeneration - Reheating, Isentropic efficiency Combustion efficiency

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	1	1	2	2	2	1	2	1	1
CO 2	2	3	2	2	1	2	2	1	1	1	2	2
CO 3	3	3	2	2	3	2	1	1	2	2	1	2
CO 4	2	3	2	2	2	2	3	1	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	2	2
CO 3	2	2	1
CO 4	2	1	2

Text books:

1. Engineering Thermodynamics, P.K. Nag, 6th Edition, Mc Graw Hill Education Pvt. Ltd.
2. Power Plant Engineering, P K Nag, 4th Edition, Mc Graw Hill Education Pvt. Ltd.
3. Thermal Engineering, P.S. Ballaney, 25th Edition, Khanna publishers.

4. Power Plant Engineering, Domkundwar, Arora, Dhanpat Rai & Co.

Reference books:

1. Thermodynamics,Cengel, 6th Edition, Tata Mc Graw- Hill Education.
2. Power Plant Technology,MMEi-Wakil 1st Edition, Tata McGraw Hill.

Course Title: Environmental Science

Course Code: MC-EE401	**Category**: Mandatory Courses
Course Title: Environmental Science	**Semester**: 4th
L-T-P: 3-0-0	**Credit: 0**
Pre-Requisites: Basic knowledge of science	

Course Outcomes:

CO1: Articulate the interconnected and interdisciplinary nature of environmental studies.

CO2: Demonstrate an integrative approach to environmental issues with a focus on sustainability.

CO3: Communicate complex environmental information to both technical and non-technical audiences and use critical thinking, problem-solving, and the methodological approaches in environmental issues.

CO4: Understand, Evaluate and Instigate the global scale of environmental problems on their roles, responsibilities, and identities as citizens, consumers and environmental actors in a complex, interconnected world.

Module 1: (6 Hours)

Basic ideas of Environment, Biosphere, its inner and outer parts, Man, Society, Environment & their interrelationship. Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, nonrenewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development. Materials balance: Steady state conservation system, steady state system with non-conservative pollutants, step function.

Module 2: (6 Hours)

Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function.
Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web. Biogeochemical Cycle- definition,

significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. Biodiversity- types, importance, Endemic species, Biodiversity Hot- spot, Threats to biodiversity, Conservation of biodiversity.

Module 3: (6 Hours)

Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.
Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget.
Lapse rate: Ambient lapse rate, Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model.

Module 4: (10 Hours)

Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds.
River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH.Lake: Eutrophication [Definition, source and effect].
Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)
Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic.

Module 5: (8 Hours)

Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol.
Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain cause, effects and control. Nature and scope of Environmental Science and Engineering.
Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN, Smog, Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green-house gases, effect of ozone modification. Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), (Statement with brief reference).

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	-	1	2	1	-	2	3	2	1	2	-	2
CO 2	-	2	1	1	2	1	3	1	1	-	1	1
CO 3	-	1	2	2	2	2	3	2	-	2	2	2
CO 4	-	1	-	-	-	2	3	-	-	-	2	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	-	2	1
CO 2	-	1	1
CO 3	-	2	2
CO 4	-	-	-

TextBooks:

1. Environmental Studies, M.P. Poonia& S.C. Sharma, Khanna Publishing House.
2. Introduction to Environmental Engineering and Science, G.M. Masters, Prentice-Hall of India Pvt. Ltd., 1991.
3.Environmental Chemistry, A. De, New Age International.

Reference Books:

1. Text Book for Environmental Studies, ErachBharucha, UGC.
2. Elements of Environmental Pollution Control, O.P. Gupta, Khanna PublishingHouse (AICTE Recommended Book).

Course Title: Electrical Machines -II Laboratory

Course Code: PC-EE491	**Category**: Professional Core Courses
Course Title: Electrical Machines -II Laboratory	**Semester**: 4th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Physics and Basic Electrical and Electronics Engineering (Theory and Laboratory).	
Course Outcomes:	
CO1: Recall the relevant theoretical information to supplement the Electric Machine-I	

Laboratory course.
CO2: Interpret working and operations of electrical machines based on basic principles for Set up testing strategies and select the proper instruments to evaluate the performance characteristics of electrical machines.
CO3: Constructan electrical experimental setup for gathering different electrical quantities and parameters for electrical machine operations.
CO4: Inspectdifferent characteristics generated from experimental data and analyse their performances.

List of Experiments:

1. Speed control of three phase slip ring induction motor by rotor resistance control.
2. Determination of regulation of the synchronous machine by Potier-Reactance method.
3. Determination of regulation of an alternator by thesynchronous impedance method.
4. Determination of equivalent circuit parameters of a single-phase induction motor.
5. Load test on single phase induction motor to obtain the performance characteristics.
6. To determine the direct axis reactance [Xd] & quadrature axis reactance [Xq] of a three-phase synchronous machine by slip test.
7. Load test on wound rotor induction motor to obtain the performance characteristics.
8. To make a connection diagram of full pitch & fractional slot winding of 18 slot squirrel cage induction motor for 6 pole & 4 pole operation.
9. Experiment to study the V-curve characteristics of a synchronous motor.
10. Study on the parallel operation of three-phase synchronous generators.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	-	-	-	-	-	-	-	-	2
CO 2	3	3	2	2	-	-	-	-	-	-	-	2
CO 3	3	2	3	2	2	-	-	-	2	-	-	3
CO 4	3	3	-	3	3	-	-	-	2	2	-	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	-
CO 2	2	-	-
CO 3	2	2	2
CO 4	3	3	3

Course Title: Digital Electronics Lab

Course Code: PC-EE492	**Category**: Professional Core Courses
Course Title: Digital Electronics Lab	**Semester**: 4th
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: Basic knowledge of Analog Electronics.	
Course Outcomes:	
CO1: Recall the convert numerical data to various number systems.	
CO2:Understand the demonstrate truth tables of different logic gates.	
CO3: Practice and design different Combinational and Sequential digital circuits.	
CO4: Analyze and evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.	

List of experiments:

1. Design of half adder, full circuit using logic gates.
2. Design of half subtractor, full subtractor circuit using logic gates.
3. Design Encoder, Decoder, Multiplexer and De Multiplexer using logic gates.
4. Design of RS and JK Flip Flop circuit using logic gates.
5. Design of T and D Flip Flop circuit using logic gates.
6. Design of Register circuit using FlipFlop.
7. Design of serial to parallel converter and parallel to serial converter.
8. Design of asynchronous up/down counters.
9. Design of synchronous up/down counters.
10. Study of A/D and D/A converter circuit.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	2	2	2	2	-	2	3	2	2
CO 2	3	3	2	3	2	2	-	-	-	3	-	-
CO 3	3	3	3	2	3	-	-	-	-	-	-	-
CO 4	3	3	2	2	3	-	-	2	-	-	-	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	2
CO 2	2	3	2
CO 3	3	3	3
CO 4	3	3	3

Course Title: Electrical and Electronics Measurement Laboratory

Course Code: PC-EE493	**Category**: Professional Core Courses
Course Title: Electrical and Electronics Measurement Laboratory	**Semester**: 4th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Basic Electrical Engineering, Electric Circuit Theory, Electromagnetism.	
Course Outcomes:	
CO1: Recall the construction and working principles of different electrical and electronic measuring instruments.	
CO2: Relate the mathematical and theoretical knowledge with the practical electrical measuring system and realize their importance.	
CO3: Identify the proper measuring instruments depending on particular application areas.	
CO4: Analyze various measuring instruments with respect to standard instruments.	

List of Experiments:

1. Instrument workshop- Observe the construction of PMMC, Dynamometer, Electro-thermal and Rectifier type of instruments, Oscilloscope and Digital multimeter.
2. Calibrate moving iron and electrodynamometer typeammeter/voltmeter by potentiometer.
3. Calibrate dynamometer type wattmeter by potentiometer.
4. Calibrate AC energy meter.
5. Measurement of resistance using Kelvin double bridge.
6. Measurement of power using Instrument transformer.
7. Measurement of power in Poly-phase circuits.

8. Measurement of frequency by Wien Bridge.
9. Measurement of Inductance by Anderson Bridge.
10. Measurement of capacitance by De Sauty Bridge.
11. Measurement of capacitance by Schering Bridge.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	2	1	-	-	-	-	-	1	-	1
CO 2	3	3	2	3	3	2	3	-	-	2	2	-
CO 3	3	3	2	2	-	3	3	-	-	2	1	3
CO 4	1	-	2	3	2	3	-	-	2	-	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	-	2
CO 2	2	3	1
CO 3	-	2	2
CO 4	2	3	3

Course Title: Control System Laboratory

Course Code: PC-EE494	**Category**: Professional Core Courses
Course Title: Control Systems Laboratory	**Semester**: 4th
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: MATLAB, PSPICE	
Course Outcomes:	
CO1: Recall the knowledge of simulation tools for control system basics.	
CO2: Interpret the mathematical model of the physical systems by conducting appropriate experiments.	
CO3: Apply different methods to find out the performance and the stability of physical systems.	
CO4: Analyze controllers for physical systems to meet the desired specifications.	

List of Experiments:

1. Familiarization with MATLAB control system toolbox, MATLAB- SIMULINK toolbox &PSPICE.
2. Determination of Step response for first order & Second order system with unity feedback on CRO & calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
3. Determination of Step response for first order & Second order system with unity feedback using MATLAB& calculation of different control system specifications.
4. Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
5. Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system toolbox for 2nd order system & determination of different control system specifications from the plot.
6. Determination of PI, PD and PID controller action of first and second order simulated process.
7. Determination of approximate transfer functions experimentally from Bode plot.
8. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead.
9. Obtain Transfer Function of a given system from State Variable model and vice versa. State variable analysis of a physical system - obtain step response for the system by simulation.
10. Study of the effects of nonlinearity in a feedback-controlled system using time response.
11. Determination of step response with a limiter nonlinearity introduced into the forward path of 2nd order unity feedback control systems. The open loop plant will have one pole at the origin and other poles will be in LHP or RHP. To verify (by simulation) that
    (i) with an open loop stable pole, the response is slowed down for larger amplitude input
    (ii) for unstable plants, the closed loop system may become oscillatory with large input amplitude.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	1	1	2	1	2	1	2	1	1
CO 2	2	2	2	2	2	1	2	1	1	1	2	2
CO 3	3	3	2	2	3	2	1	1	2	2	1	1
CO 4	2	3	2	2	2	2	3	1	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	1
CO 2	1	3	2
CO 3	2	2	1
CO 4	2	1	1

SEMESTER –V

Course Title: Power Electronics

Course Code: PC-EE501	**Category**: Professional Core Courses
Course Title: Power Electronics	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical & Electronics Engineering.Analog Electronics.	

Course Outcomes:

CO1: Recall basic semiconductor physics related to the properties of Power Electronics.

CO2: Understand the working and operations of various power semiconductor switches and converters.

CO3: Demonstrate output behaviors for different power electronics converters and illustrate operational characteristics of various power semiconductor switches.

CO4:Analyze the use of different power electronics switches and converters based on specific requirements and select proper parameter values to provide the target solution.

Module 1: Introduction: (3 hours)
Concept of power electronics, application of power electronics, advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS, IGBT.

Module 2: Thyristor (8 hours)
Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor models of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, design of snubber circuit, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.

Module 3: Phase controlled converters (7 hours)
Principle of operation of single phase and three phase half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, single phase and three phase dual converters.

Module 4: DC-DC converters (6 hours)
Principle of operation, concept of Buck, Boost and Buck-Boost Chopper, control strategies, types of choppers circuits based on quadrant of operation, performance parameters, and switching mode regulators.

Module 5: Inverters (8 hours)
Definition, classification of inverters based on nature of input source, wave shape of output voltage, Principle of operation of single phase and three phase bridge Voltage Source Inverter with R and R-L loads, Current Source Inverter, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters by pulse width modulation.

Module 6: AC controllers (4 hours)
Principle of on-off and phase control, single phase controllers with R and R-L loads.
Principle of operation of cycloconverters, single phase to single phase step up and step down cycloconverters.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	-	-	-	-	-	-	1	2	1	2
CO 2	3	3	2	2	-	2	2	-	1	2	2	2
CO 3	3	3	2	2	2	2	2	-	1	2	2	2
CO 4	3	3	2	2	2	2	2	1	1	2	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	2
CO 2	2	2	2
CO 3	2	2	2
CO 4	3	2	3

Text Books:

1. Power electronics: circuits, devices, and applications, M. H. Rashid, Pearson Education India, 2009.
2. Power Electronics, P.S. Bimbhra, Khanna Publishers, 3rd Edition.
3. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc Graw Hill.2007.

Reference Books:

1. Power Electronics, Mohan, Undeland &Robbins, Wiley India.
2. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall, Power Electronics, V.R. Moorthi, Oxford,2005.

Course Title: Power System-I

Course Code: PC-EE502	**Category**: Professional Core Courses
Course Title: Power System-I	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites:Basic Electrical Engineering, Electric Circuit Theory, Electromagnetic field theory, Electrical Machine.	

Course Outcomes:

CO1: Recall the different concepts of previously learned courses and mathematical operations which can be applied to power generation, transmission and distribution systems.

CO2: Interpret the basic structure of the power system and its components, various methods of conventional and renewable power generation and the concept of power transmission system.

CO3:Utilize the concepts to calculate the different parameters of transmission line,Short circuit calculation for symmetrical and unsymmetrical fault, power system protection and voltage surges.

CO4: Analyze the effect of various modified parameters on the state of power generation, transmission, distribution system and compare the different types of power system fault calculation and protection etc. to improve power system stability and reliability.

Module 1:Basic Concepts (4 hours)
Evolution of Power Systems and Present-Day Scenario. Structure of a power system, Basic concepts of Thermal, Hydro-electric, Diesel, Nuclear, and Gas Turbine power generating stations, Renewable Energy Sources: Solar, Wind etc.. Bulk Power Grids and Micro-grids. Distributed Energy Resources. Energy Storage.

Module 2: Distribution Systems (6 hours)
Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation. Voltage Drop Calculations (Numerical Problems) in A.C. Distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages.

Module 3: Power Flow Analysis (10 hours)
Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non-linear algebraic equations – Gauss

Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.
Module 4:Power System Components (16 hours) Overhead Transmission Lines: Electrical and magnetic field around conductors. Resistance, Inductance and capacitance of two wire line, 3 phase transposed and un-transposed lines, Concept of GMD and GMR. Short, medium and long transmission lines, ABCD constants,Ferranti effect, Power Transfer, Voltage profile and Reactive Power, Surge Impedance Loading. Insulators: Types, Voltage distribution across a suspension insulator string, String Efficiency calculation, Sag Calculation, Corona, Underground cables: structure, parameters and grading. Tariff and its calculation. Per-unit System and per-unit calculations.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	1	1	1	1	1	1	1	1
CO 2	3	2	2	2	1	2	2	2	1	2	1	2
CO 3	3	3	3	3	3	3	2	2	2	2	2	3
CO 4	3	3	2	3	2	3	2	1	2	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	1
CO 2	2	1	2
CO 3	3	3	3
CO 4	3	3	3

Text Books:

1. Electrical Power System, Subir Roy, Prentice Hall.
2. Power System Engineering, Nagrath &Kothery, TMH.
3. Switchgear protection and power systems, Sunil S Rao, Khanna Publications.

References Books:

1.A text book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S. Bhatnagar & A. Chakrabarti, Dhanpat Rai & CO.
2. Elements of power system analysis, C.L. Wadhwa, New Age International.
3. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors.

Course Title: Microprocessor and Microcontroller

Course Code: PC-EE503	**Category**: Professional Core Courses
Course Title: Microprocessor and Microcontroller	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical and Electronics Engineering, Analog Electronics, and Digital Electronics	
Course Outcome:	
CO1: Recall basic binary math operations and semiconductor physics related to the internal architecture of the Microprocessors and Microcontrollers and their operation.	
CO2: Understand the basic architecture and programming nomenclature of Microprocessors and Microcontrollers.	
CO3: Interpret the use of different instructions and registers of Microprocessors and Microcontrollers that will provide the target solutions.	
CO4: Analyze different machine cycles associated with different instructions for different addressing modes and distinguish the difference between different microprocessors, microprocessor and microcontroller, and different interfacing techniques.	
MODULE 1: 8085 MICROPROCESSOR (14 hours) Architecture of 8085 Microprocessor, block diagram representation, Bus configuration, application of microprocessor as CPU module, memory, ROM & RAM families, basic concepts of I/O peripheral devices, memory mapping, concept of word length. Use of microprocessor as programmable device, basic concept of algorithm, flowchart, assembler, compiler, editor and debugger Introduction to assembly language & machine language programming, Instruction set, Subroutine & stack, interrupt, Timing diagram, External Communication Interface, application in LED, LCD display, stepper motor.	
MODULE 2: 8086 MICROPROCESSORS (8 hours) Introduction to 8086 Microprocessor, Architecture, addressing modes, Instruction set, Assembly language programming, 8086 System bus structure, 8086 signals.	

Module 3: 8051 Microcontroller (10 Hours)

Architecture of a typical Microcontroller(eg.8051), concept of embedded microcontroller, memory unit, block diagram representation, CPU,BUS configuration,register banks and stack,SFRs, flags,DPTR register,Program Counter,Basic instructions of 8051 microcontroller, assembly language programming, different addressing modes.

Module 4: Memory and I/O Interfacing (4 Hours)

Programmable peripheral interface, Architecture of 8255A, interfacing of ADC, keyboard, seven Segment display. Programmable interval timer (eg.8254).

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	1	-	1	-	1	2	1	1
CO 2	3	3	2	2	2	2	1	-	2	1	1	2
CO 3	3	2	2	2	2	2	1	1	1	3	1	2
CO 4	2	2	2	2	2	2	1	1	-	-	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	1
CO 2	1	2	2
CO 3	-	2	3
CO 4	-	1	2

Text Books:

1. R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996
2. S.K.Venkatesh, “, 8051 microcontroller & embedded systems”, S.K.Kataria& Sons,2007-2008.
3. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education,2007.
4. K. J. Ayala, “8051 Microcontroller”, Delmar CengageLearning,2004.

Reference Books:

1. K.Kant, “Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085,8086,8051,8096 ” PHI Learning Private Limited,2010.
2. N.S.Kumar, M.Saravanan, S.Jeevananthan , “Microprocessors and Microcontrollers” Oxford University Press,2013.
3. M.K.Patel, “The 8051:Microcontroller based Embedded Systems” McGraw Hill Education (India) Private Limited,2014.

Course Title: Data Structure and Algorithm

Course Code: OE-EE501A	**Category**: Open Elective Courses
Course Title: Data Structure and Algorithm	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Programming for problem solving, Mathematics	

Course Outcomes:

CO1: Demonstrate proficiency in foundational data structures and algorithms to solve computational problems effectively.

CO2: Apply algorithmic thinking and asymptotic analysis to design and evaluate efficient algorithms for diverse computational tasks and data manipulation operations.

CO3: Analyse algorithm performance using time-space complexity analysis and optimize algorithms for improved efficiency and scalability in various applications.

CO4: Demonstrate the ability to apply various data structures and algorithms effectively to solve practical problems encountered in different applications and domains.

Module 1: Introduction (10 Hours)
Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.

Module 2: Stacks and Queues (10 Hours)
ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.

Module 3: Singly linked lists(10 Hours)
Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion in to, Deletion from linked list; Linked representation of Stack andQueue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis.

Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.
Module 4: Sorting and Hashing:(6 Hours) Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: BasicTerminologies and Representations, Graph search and traversal algorithms and complexity analysis.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	2	1	1	1	1	1	1	2
CO 2	3	3	2	2	3	1	1	1	2	1	1	2
CO 3	3	3	3	3	3	1	1	1	2	2	1	2
CO 4	3	3	3	2	3	2	2	1	3	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	2
CO 2	2	3	2
CO 3	3	3	2
CO 4	3	3	3

Text Books:

1. Data Structures and Program Design In C, 2/E by Robert L. Kruse, Bruce P. Leung. PHI
2. Data Structure & Algorithms Using C, R.S. Salaria, 5th Ed., Khanna Publishing House
3. Data Structures in C, Aaron M. Tenenbaum. Pearson.
4. Data Structure, S. Lipschutz.. Mc Graw Hill.

Reference Books:

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest,Clifford Stein, MIT press.
2. Expert Data Structures with C++, R.B Patel, Khanna Publishing House.
3. Fundamentals of Data Structures of C, Ellis Horowitz, SartajSahni, Susan Andersonfreed, MIT Press.
4. Data Structures Using C, ReemaThareja. Oxford University press.
5. Data Structure Using C, 2/e by A.K. Rath, A. K. Jagadev. SCITECH.
6. Data Structures through C, YashwantKanetkar, BPB Publications.

Course Title: Electronic Devices

Course Code: OE-EE501B	**Category**: Open Elective Courses
Course Title: Electronic Devices	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Semiconductor Physics, Basic Electronics	
Course Outcomes:	
CO1: Know the characteristics of various components.	
CO2: Understand the utilization of components.	
CO3: Understand the biasing techniques.	
CO4: Design and analyze small signal amplifier circuits.	
Module 1: Diode and Applications (8 hours) Diode - Static and Dynamic resistances, Equivalent circuit, Load line analysis, Diffusion and Transition Capacitances, Diode Applications: Switch-Switching times. Rectifier - Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Rectifiers with Capacitive and Inductive Filters, Clippers-Clipping at two independent levels, Clamper-Clamping Circuit Theorem, Clamping Operation, Types of Clampers.	
Module 2: Bipolar Junction Transistor (BJT) (8 hours) Principle of Operation, Common Emitter, Common Base and Common Collector Configurations, Transistor as a switch, switching times, Transistor Biasing and Stabilization - Operating point, DC & AC load lines, Biasing - Fixed Bias, Self Bias, Bias Stability, Bias Compensation using Diodes.	
Module 3: Junction Field Effect Transistor (FET) (8 hours) Construction, Principle of Operation, PinchOff Voltage, Volt-Ampere Characteristic, Comparison of BJT and FET, Biasing of FET, FET as Voltage Variable Resistor. Special Purpose Devices: Zener Diode - Characteristics, Voltage Regulator. Principle of Operation - SCR, Tunnel diode, UJT, Varactor Diode	
Module 4: Analysis and Design of Small Signal Low Frequency BJT Amplifiers (12 hours) Transistor Hybrid model, Determination of h-parameters from transistor characteristics, Typical values of hparameters in CE, CB and CC configurations, Transistor amplifying action, Analysis of CE, CC, CB Amplifiers and CE Amplifier with emitter resistance, low frequency response of BJT Amplifiers, effect of coupling and bypass capacitors on CE Amplifier. **FET Amplifiers:** Small Signal Model, Analysis of JFET Amplifiers, Analysis of CS, CD, CG JFET Amplifiers. MOSFET Characteristics in Enhancement and Depletion mode, Basic Concepts of MOS Amplifiers.	

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	2	1	1	1	2	2	1	1
CO 2	3	3	2	2	3	1	1	1	2	3	1	1
CO 3	3	3	3	3	3	1	1	1	3	3	1	1
CO 4	3	3	3	2	3	2	2	1	2	3	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	1
CO 2	2	3	1
CO 3	3	3	1
CO 4	2	3	2

Text Books:

1. Electronic Devices and Circuits- Jacob Millman, McGraw Hill Education.
2. Electronic Devices and Circuits theory– Robert L. Boylestead, Louis Nashelsky, 11th Edition, 2009, Pearson.

Reference Books:

1. The Art of Electronics, Horowitz, 3rd Edition Cambridge University Press.
2. Electronic Devices and Circuits, David A. Bell – 5 th Edition, Oxford.
3. Pulse, Digital and Switching Waveforms –J. Millman, H. Taub and Mothiki S. Prakash Rao, 2Ed., 2008, Mc Graw Hill.

Course Title: Communication Engineering

Course Code: OE-EE501C	**Category**: Open Elective Courses
Course Title: Communication Engineering	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Physics, Basic Electronics	
Course Outcomes:	
CO1: Know the mutual information and channel capacity theorem.	
CO2: Know the properties of white noise, filtering of random signals through LTI systems.	
CO3: Analyze the analog communications.	
CO4: Analyze digital communications using digital modulation schemes.	

Module 1: Random Processes(8 hours) Random Processes: Auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems.
Module 2: Analog Communications(8 hours) Analog Communications: Amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.
Module 3: Information Theory(8 hours) Information Theory: Entropy, mutual information and channel capacity theorem.
Module 4: Digital Communications(12 hours) Digital Communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER. Fundamentals of error correction, Hamming codes, CRC.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	2	-	-	-	2	2	1	1
CO 2	3	3	-	-	3	-	-	-	2	3	1	1
CO 3	3	3	-	-	3	-	-	-	3	-	1	1
CO 4	3	3	3	2	3	-	-	-	2	-	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	1
CO 2	2	3	1
CO 3	3	3	1
CO 4	2	3	2

Text Books:

1. Communication System by Simon Haykins.
2. Digital and Analog Communications 1st Edition by K. Sam Shanmugam.

Reference Books:

1. Modern Digital and Analog Communications by B.P. Lathi2008, Mc Graw Hill.

Course Title: Digital Signal Processing

Course Code: PE-EE501A	**Category**: Professional Elective Courses
Course Title: Digital Signal Processing	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Linear Algebra, Complex Number.	

Course Outcomes:

CO1: Recall the concept of signals and signal processing tools to check the spectral content in periodic and aperiodic signals, determine if the system is periodic, LTI, or recursive and also check the stability and causality condition of the system.

CO2: Demonstrate how to use Fourier transform, Z-Transform, DFT, DTFT, FFT to find the frequency response of the system.

CO3: Apply different convolution techniques to find the response of the LTI system and different window techniques to design filters.

CO4: Analyze and compare Continuous time system with discrete time system, Fourier transform with Z-Transform, DFT and DTFT, DIT FFT & DIF FFT, and the different window techniques.

Module 1: Discrete-time signals and systems(6 hours)
Brief idea about the DSP, concept of continuous and discrete-time signal, basic idea of sampling and reconstruction of signal, Representation of continuous time signals by its samples- Types of sampling, aliasing, sequences, -periodic, energy, power, unit step, unit ramp, unit impulse & complex exponentials, arithmetic operations on sequences, time response analysis of discrete time systems.

Module 2: LTI systems(6 hours):
Definition, representation, Concept of convolution, graphical, analytical and matrix methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, Circular Convolution, Properties of Circular Convolution, Sectioned convolution, Overlap-Save and Overlap-Add methods with examples and exercises. Stability and causality conditions, recursive and non-recursive systems.

Module 3: Z-Transforms(8 hours)

Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

Module 4: Discrete Time Fourier Transform (DTFT) & Discrete Fourier Transform (DFT)(6 hours)

Frequency Domain Analysis, Discrete Time Fourier Transform, Conditions and properties of DTFT, Discrete Fourier Transform, Properties of DFT, Concept and relations for DFT/IDFT, Relation between DTFT & DFT, Twiddle factors and their properties, Inverse Discrete Fourier Transform.

Module 5: Fast Fourier Transforms (FFT)(4 hours)

Fast Fourier Transform, Properties of FFT, Radix-2 algorithm, decimation-in-time and decimation-in-frequency algorithm, Butterflies, Bit reversal, Examples for DIT & DIF FFT Butterfly computations and exercises.

Module 6: Filter design(6 hours)

Introduction to Digital Filter, Design of IIR filters: Butterworth and Chebyshev filter design, Conversion to digital IIR Filter using impulse invariance technique, Bilinear Transformation, and approximation of derivatives, Realization of Digital Filters, Direct form – I realization Direct form – II realization, Design of FIR Filter: Rectangular, Blackmann Hamming, Hanning and Kaiser window.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	2	2	-	-	-	1	3	2	2
CO 2	3	2	1	3	2	1	1	-	1	3	2	2
CO 3	3	3	3	3	3	2	1	2	2	3	3	3
CO 4	3	2	2	2	3	2	1	1	2	3	3	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	1	-
CO 2	3	2	-
CO 3	3	3	3
CO 4	3	3	3

Text Books:

1. Digital Signal Processing, P. Ramesh Babu.
2. Digital Signal Processing-A computer based approach, S. Mitra, TMH.
3. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI.
4. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling,S.L. Harris, Cengage Learning.

Reference Books:

1. Digital Signal Processing, Chen,OUP.
2. Digital Signal Processing, Johnson,PHI.
3. Digital Signal Processing using MATLAB, Ingle,Vikas.
4. Digital Signal Processing, Ifeachor, Pearson Education.
5. Digital Signal Processing, A.V. Oppenhein& R.W. Shaffer,PHI.
6. Theory and application of Digital Signal Processing, L.R. Rabiner& B. Gold,PHI.
7. Digital Signal Processing, Ashok Ambarder, CengageLearning.
8. Digital Signal Processing, S. Salivahanan, A. Vallavaris& C. Gnanpruja,TMH.

Course Title: Computational Electromagnetic

Course Code: PE-EE501B	**Category**: Professional Elective Courses
Course Title: Computational Electromagnetic	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Electromagnet, Programming for problem solving, Mathematics	
Course Outcomes:	
CO1: Understand the fundamentals and overview of Partial Differential Equation and Time-Domain Methods.	
CO2: Understand one-dimensional scalar wave equation.	
CO3: Understand the concept of Maxwell's' Equations and Yee Algorithm.	
CO4: Understand the Numerical Stability Schemes.	
Module 1: Overview (8 Hours) Background :The Heritage of the 1980's , The Rise of Partial Differential Equation Methods , Interdisciplinary Impact of Emerging Time-Domain PDE Solvers, History of Space-Grid Time-Domain	

Techniques for Maxwell's Equations , General Characteristics of Space-Grid Time-Domain Approaches :Classes of FD-TD and FV-TD Algorithms , Predictive Dynamic Range , Scaling to Very Large Problem Sizes : Algorithm Scaling Factors , Computer Architecture Scaling Factors , Defense Applications, Dual-Use Electromagnetics Technology.

Module 2: One-Dimensional Scalar Wave Equation (8 Hours)

Propagating-Wave Solutions, Finite Differences, Finite-Difference Approximation of the Scalar Wave Equation, Dispersion Relations for the One-Dimensional Wave Equation, Numerical Phase Velocity, Numerical Group Velocity, Numerical Stability: The Time Eigen value Problem, The Space Eigen value Problem, Enforcement of Stability.

Module 3: Introduction to Maxwell's' Equations and the Yee Algorithm (8 Hours)

Maxwell's Equations in Three Dimensions**,** Reduction to Two Dimensions**:** TM Mode**,** TE Mode**,** Reduction to One Dimension:TM Mode **,** TE Mode**,** Equivalence to the Wave Equation in One Dimension **,** Yee Algorithm**.**

Module 4: Numerical Stability (8 Hours)

Basic-Stability Analysis Procedure, TM Mode**,** Time Eigen value Problem, Space Eigen value Problem, Enforcement of Stability**,** Extension to the Full Three-Dimensional Yee Algorithm, Generalized Stability Problem: Boundary Conditions, Variable and Unstructured Meshing, Lossy, Dispersive, Nonlinear, and Gain Materials

Module 5: Numerical Dispersion (4 Hours)

Basic Procedure**,** Substitution of Traveling-Wave Trial Solution, Extension to the Full Three-Dimensional Yee Algorithm, Comparison with the Ideal Dispersion Case, Reduction to the Ideal Dispersion Case for Special Grid Conditions**,** Dispersion-Optimized Basic Yee Algorithm, Dispersion-Optimized Yee Algorithm with Fourth-Order Accurate Spatial Central Differences: Formulation, Example, Pros and Cons

CO & PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	1	1	1	-	-	-	-	1	-	1
CO 2	3	3	2	3	2	2	2	-	1	-	2	2
CO 3	3	3	2	2	2	2	2	1	1	-	1	2
CO 4	2	3	2	2	2	3	2	1	1	-	1	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	3
CO 2	3	2	3
CO 3	3	2	3
CO 4	3	2	2

Text Books:

1. Taflove, A. and Hagness, S.C., Computational Electrodynamics, Artech House (2006).

Reference Books:

1. Sullivan, D.M., Electromagnetic Simulation Using the FDTD Method, IEEE Computer SocietyPress(2000).

Course Title: IOT Based Electrical Systems

Course Code: PE-EE501C	**Category**: Professional Elective Courses
Course Title: IOT Based Electrical Systems	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical Engineering, Basic Computer	
Course Outcomes:	
CO1: Demonstrate Internet of Things Promises, scope and applications.	
CO2: Analyze technologyof power management module, RF module and sensing module.	
CO3: Interface IOT in different electrical software related system.	
CO4: Apply IOT in different electrical hardware project.	
Module 1: Introduction(8 hours) Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structureof IoT– IoT Map Device	
Module 2: IOT Sensors(8 hours) Industrial sensors – Description & Characteristics–First Generation – Description &Characteristics–Advanced Generation – Description & Characteristics–Integrated IoTSensors – Description & Characteristics–Polytronics Systems – Description &Characteristics–Sensors' Swarm – Description & Characteristics–Printed Electronics –Description & Characteristics–IoT Generation Roadmap.	

Module 3: Technological Analysis (8 hours)

Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sensing Module.

Module 4: IOT Applications (12 hours)

Creating the sensor project - Preparing Raspberry Pi/ ARM Cortex - Clayster libraries – HardwareInteracting with the hardware - Interfacing the hardware- Internal representation ofsensor values - Persisting data - External representation of sensor values – Exportingsensor data - Creating the actuator project- Hardware - Interfacing the hardware -Creating a controller - Representing sensor values - Parsing sensor data – Calculatingcontrol states - Creating a camera - Hardware -Accessing the serial port on RaspberryPi/ ARM Cortex - Interfacing the hardware - Creating persistent default settings – Addingconfigurable properties - Persisting the settings - Working with the current settings - Initializing the camera.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	1	1	1	1	-	1	-	2	1
CO 2	3	2	1	1	-	-	-	-	2	-	1	1
CO 3	3	2	1	-	-	1	2	-	1	-	1	1
CO 4	3	1	-	1	-	-	-	1	1	-	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	1	1	1
CO 2	1	1	2
CO 3	1	-	1
CO 4	-	1	1

Text Books:

1. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights,2014.

Reference Books:

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015.

Course Title: Advanced Control System

Course Code: PE-EE 502A	**Category**: Professional Elective Courses
Course Title: Advanced Control System	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic knowledge of Control system and Physical system.	
Course Outcomes:	
CO1: Recall the use of linear algebra and matrix theory to study and form state variable control systems.	
CO2: Compare and express the respective behaviors of linear and nonlinear systems, as well as discrete and continuous systems.	
CO3: Apply a range of graphical and analytical methods to describe and understand the stability of nonlinear systems and discrete systems effectively.	
CO4: Analyze different design concepts of linear and nonlinear control theory in continuous and discontinuous domains.	
Module 1: State variable model of continuous dynamic systems:(14 hours) Converting higher order linear differential equation into state variable (SV) form. Obtaining SV model from transfer function. Obtaining characteristic equation and transfer functions from SV model. Obtaining SV equations directly from R-L-C and Spring-Mass-Dashpot systems.Concept and properties associated with state equations. Linear Transformations on state variables. Canonical forms of SV equations. Companion forms. Solutions of state equations. State transition matrix. Properties of state transition matrix.Controllability and observability. Linear state variable feedback controller. The pole allocation problems. Linear system design by state variable feedback.	
Module 2: Nonlinear Control Systems (12 hours) Block diagram and state variable representations. Characteristics of common nonlinearities. Phase plane analysis of linear and non-linear second order systems. Methods of obtaining phase plane trajectories by graphical method-isoclines method. Qualitative analysis of simple control systems by phase plane methods.Describing function method. Limit cycles in non-linear systems. Prediction of limit cycles using describing function. Stability concepts for nonlinear systems.	

BIBO vs. State stability. Lyapunov's definition. Asymptotic stability. Global asymptotic stability. The first and second methods of Lyapunov to analyze non-linear systems.

Module 3: Analysis of discrete time (sampled data) systems using Z transforms: (10 hours)
Difference equations. Inverse Z transform. Stability and damping in Z domain. Practical sampled data systems and computer control. Practical and theoretical samplers. Sampling as impulse modulation. Sampled spectra and aliasing. Antialiasing filters. Zero order hold. Approximation of discrete (Z domain) controllers with ZOH by Tustin transform and other methods. State variable analysis of sampled data system.Stability analysis of closed-loop systems in the z-plane, Design based on the root-locus method, Digital compensator design using frequency response.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	1	1	1	1	1	2	2	1	2	1	1
CO 2	2	3	2	2	2	2	2	2	2	1	2	2
CO 3	3	2	2	2	3	2	1	1	1	2	1	2
CO 4	2	3	2	2	2	2	3	2	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	2	2
CO 3	1	2	3
CO 4	2	1	2

Text Books:

1. Slotine& Li, Applied Non-Linear Control, Englewood Cliffs, NJ: Prentice-Hall, (1991).
2. Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice-Hall of India Private Limited (2003).
3. Ogata, K., Discrete-time Control Systems, Pearson Education (2005).

Reference Books:

1. Sliding Mode Control – Theory and Applications, Christopher Edwards and Sarah K. Spurgeon, CRC Press.
2.Digital Control and State Variable Methods, M. Gopal, TMH Publication.
3. Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age International Publishers.

Course Title: Machine Dynamics

Course Code: PE-EE502B	**Category**: Professional Elective Courses
Course Title: Machine Dynamics	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical Engineering, Physics.	
Course Outcomes:	
CO1: Derive Kron's Primitive machine for an unified electrical machine mode.	
CO2: Derive the mathematical model and control a 3- phase Induction motor.	
CO3: Derive the mathematical model of synchronous machine.	
CO4: Analyze a three phase synchronous machine under transient conditions.	
Module 1: Modeling Concepts (8 hours) Basic Two-pole machine representation of commutator machines, 3-ph synchronous machine with and without damper bars and 3-ph induction machine, Kron's primitive machine-voltage, current and torque equations. Real time model of a two phase induction machine-transformation to obtain constant matrices-thee phase to two phase transformation- power equivalence.	
Module 2: Modeling Of Three Phase Induction Machine (8 hours) Generalized model in arbitrary reference frame- Electromagnetic torque – Derivation of commonly used induction machine models- Stator reference frame model- Rotor reference frame model- Synchronously rotating frame model- Equations in flux linkages - per unit model-Dynamic Simulation- Small signal equations of induction machine.	
Module 3: Synchronous Machine Modeling (8 hours) Mathematical model of a sep. excited DC motor- steady state and transient analysis - Transfer function of a sep. excited DC motor – Mathematical model of a DC series motor, shunt motor linearization techniques for small perturbations. Synchronous machine inductances – voltage equations in the rotor's DQ0 reference frame- electromagnetic torque-current in terms of linkages.	
Module 4: Dynamic Analysis of Synchronous Machine (12 hours) Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria- simulation of three phase synchronous machine – modeling of PMSM.	

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	2	2	2	-	1	-	-	-
CO2	3	2	2	3	2	2	2	1	-	1	2	1
CO3	3	2	3	3	3	2	2	-	1	2	2	2
CO4	3	3	2	2	2	2	3	1	2	3	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	1	2	2
CO 2	2	3	2
CO 3	3	3	3
CO 4	2	2	2

Text Books:

1. R.Krishnan "Electric Motor Drives - Modeling, Analysis& control"- Pearson Publications-1st edition -2002
2. P.C.Krause, Oleg Wasynczuk, Scott D. Sudhoff "Analysis of Electrical Machinery and Drive systems", IEEE Press,2nd Edition.

Reference Books:

1.Chee Mun Ong "Dynamic simulation of Electric machinery using Matlab / Simulink" – Prentice Hall,2000.

Course Title: Computer Architecture

Course Code: PE-EE502C	**Category**: Professional Elective Courses
Course Title: Computer Architecture	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Computer, Mathematics.	
Course Outcomes:	
CO1: Explain the concepts of parallel computing and hardware technologies.	
CO2: Compare and contrast the parallel architectures.	
CO3: Illustrate parallel programming concepts	
CO4: Analyze hardware technologies.	
Module 1: Theory of Parallelism (8 hours) Parallel Computer Models, The State of Computing, Multiprocessors and Multicomputer, Multivector and SIMD Computers, PRAM and VLSI Models, Program and Network Properties, Conditions of Parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architectures, Principles of Scalable Performance, Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws. For all Algorithm or mechanism any one example is sufficient.	
Module 2: Hardware Technologies 1 (8 hours) Processors and Memory Hierarchy, Advanced Processor Technology, Superscalar and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology. For all Algorithms or mechanisms any one example is sufficient. **Hardware Technologies 2:** Bus Systems, Cache Memory Organizations, Shared Memory Organizations, Sequential and Weak Consistency Models, Pipelining and Superscalar Techniques, Linear Pipeline Processors, Nonlinear Pipeline Processors. For all Algorithms or mechanisms any one example is sufficient	

Module 3: Parallel and Scalable Architectures (8 hours)

Multiprocessors and Multi computers, Multiprocessor System Interconnects, Cache Coherence and Synchronization Mechanisms, Message Passing Mechanisms, Multivector and SIMD Computers, Vector Processing Principles, Multivector Multiprocessors, Compound Vector Processing, Scalable, Multithreaded, and Dataflow Architectures, Latency-Hiding Techniques, Principles of Multithreading, Fine Grain Multicomputers. For all Algorithms or mechanisms any one example is sufficient.

Module 4: Software for parallel programming (12 hours)

Parallel Models, Languages, and Compilers, Parallel Programming Models, Parallel Languages and Compilers, Dependence Analysis of Data Arrays. Instruction and System Level Parallelism, Instruction Level Parallelism, Computer Architecture, Contents, Basic Design Issues, Problem Definition, Model of a Typical Processor, Compiler-detected Instruction Level Parallelism, Operand Forwarding, Reorder Buffer, Register Renaming, Tomasulo"s Algorithm. For all Algorithms or mechanisms any one example is sufficient.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	1	1	1	1	1	2	2	1	2	1	1
CO 2	2	3	2	2	2	2	2	2	2	1	2	2
CO 3	3	2	2	2	3	2	1	1	1	2	1	2
CO 4	2	3	2	2	2	2	3	2	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	2	2
CO 3	1	2	3
CO 4	2	1	2

Text Books:

1. Kai Hwang and Naresh Jotwani, Advanced Computer Architecture (SIE): Parallelism, Scalability, Programmability, McGraw Hill Education 3/e. 2015.

Reference Books:

1. John L. Hennessy and David A. Patterson, Computer Architecture: A quantitative approach, 5th edition, MorganKaufmann Elseveir, 2013.

Course Title: Power Electronics Laboratory

Course Code: PC-EE 591	**Category**: Professional Core Courses
Course Title: Power Electronics Laboratory	**Semester**: 5th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Basic Electrical Engineering and Analog Electronics.	
Course Outcomes:	
CO1: Relate relevant information of the course Power Electronics for performing different laboratory experiments.	
CO2: Understand the need of different instruments with proper range and familiarize with PSpice software for performing experiments on Power Electronics switches and converters.	
CO3: Develop different types of circuits in a team for testing power semiconductor switches and converters keeping in mind technical, economical, safety issues.	
CO4: Analyze the operating characteristics of switches and performance of different power electronics converters based on the obtained result and discussion amongst team members and distinguish the difference (if any) between the practical result obtained with the theoretical concepts.	

List of Experiments: (Any Ten)

1. Study of performance of single-phase half wave uncontrolled converters (simulation).
2. Study of performance of single-phase full wave uncontrolled converters (simulation).
3. Study of performance of three phase uncontrolled converters (simulation).
4. Study of performance of single-phase half wave-controlled converters (simulation).
5. Study of performance of single-phase full wave-controlled converters (simulation).
6. Study of the characteristics of an SCR.
7. Study of the characteristics of a TRIAC.
8. Study of different triggering circuits of an SCR
9. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
10. Study of performance of single-phase half-controlled bridge converters.
11. Study of performance of step-down chopper.
12. Study of performance of step-up chopper.

13. Study of performance of PWM bridge inverter
14. Study of the performance of three phase-controlled inverter (simulation).

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	3	2	2	1	2	-	-	-	2	1	2
CO 2	2	3	3	3	3	2	-	-	-	3	2	2
CO 3	2	3	3	3	3	3	2	2	3	3	2	2
CO 4	3	3	3	3	3	3	2	2	3	3	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	2
CO 2	2	3	2
CO 3	3	3	3
CO 4	3	3	3

Course Title: Power System-I Laboratory

Course Code: PC-EE 592	**Category**:Professional Core Courses
Course Title: Power System-I Laboratory	**Semester**: 5th
L-T-P: 0:0:2	**Credit: 1**
Pre-Requisites: P-SPICE, Basic Electrical Engg.	
Course Outcomes:	
CO1: Identify relevant information to supplement the Electric Power system I (EE502) course and Set up testing strategies and select proper instruments to evaluate performance characteristics of transmission lines, insulators and distribution systems.	
CO2: Apply power to hardware models of transmission lines and dc distribution systems to evaluate their performance characteristics and compare them with the results obtained from computer simulations using PSPICE.	
CO3: Develop testing and experimental procedures on different types of insulating materials and analyze their operation under different levels of electrical stress.	

CO4: Practice different types of wiring and devices connections keeping in mind technical, economical, safety issues also evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.

List of Experiments:

1. Determination of generalized constants A, B, C, D for long transmission lines
2. Simulation of DC distribution by network analyzer.
3. Measurement of earth resistance by earth tester.
4. Dielectric strength test of insulating oil.
5. Determination of breakdown strength of solid insulating material.
6. Different parameter calculation by power circle diagram.
7. Study of different types of insulators.
8. Active and reactive power control of alternator.
9. Study and analysis of an electrical transmission line circuit with the help of PSPICE.
10. Formation of Bus Admittance Matrix.
11. Study of AC load flow using Gauss-Seidal Method.
12. Study of AC load flow using Newton-Raphson Method.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	_	2	1	1	1	1	1	1	1
CO 2	3	2	2	2	1	2	1	1	2	2	2	2
CO 3	3	2	3	2	2	3	2	1	2	1	2	3
CO 4	3	2	2	1	2	2	2	2	2	2	3	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	2	3	3
CO 3	2	3	2
CO 4	1	2	1

Course Title: Micro-processor and Micro-controller laboratory

Course Code: PC-EE593	**Category**: Professional Core Courses
Course Title: Microprocessor and Microcontroller Laboratory	**Semester**: 5th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Physics and Basic Electrical and Electronics Engineering (Theory and Laboratory).	
Course Outcomes:	
CO1: Relate relevant information of the course Microprocessor and Microcontroller for performing different laboratory experiments.	
CO2: Familiarize with different kits and software of Microprocessors and Microcontrollers.	
CO3: Develop different assembly language programs as per the problem statement.	
CO4: Analyze contents of different registers at different stages of the assembly language program.	

List of Experiments (perform any ten):

1. Familiarization with 8085 trainer kit, process of storing and viewing of data.
2. Familiarization with 8085 simulator.
3. Compute an assembly language program to add two 8 bit numbers using 8085 trainer kit/simulator.
4. Compute an assembly language program to complement a given number using 8085 trainer kit/simulator.
5. Compute an assembly language program to perform Logical operations (eg. AND, OR etc.) using 8085 trainer kit/simulator.
6. Compute an assembly language program to find the largest number among a group of data using an 8085 trainer kit/simulator.
7. Compute an assembly language program to find the smallest number among a group of data using 8085 trainer kit/simulator.
8. Compute an assembly language program to copy a block of data from one memory location to the other, in the same order using 8085 trainer kit/simulator.

9. Compute an assembly language program to copy a block of data from one memory location to the other, in the reverse order using 8085 trainer kit/simulator.
10. Compute an assembly language program to obtain the square of a decimal number from a look-up table using 8085 trainer kit/simulator.
11. Compute an assembly language program to obtain the square-root of a decimal number from a look-up table using 8085 trainer kit/simulator.
12. Compute an assembly language program to Sequence a group of numbers in ascending order using 8085 trainer kit/simulator.
13. Compute an assembly language program to Sequence a group of numbers in descending order using 8085 trainer kit/simulator.
14. Compute an assembly language program for Addition of three or more 8-bit numbers using 8085 trainer kit/simulator.
15. Compute an assembly language program to pack a BCD number using 8085 trainer kit/simulator.
16. Compute an assembly language program to unpack a BCD number using 8085 trainer kit/simulator.
17. Compute an assembly language program for Addition of two BCD numbers using 8085 trainer kit/simulator.
18. Compute an assembly language program to convert from ASCII to Hexadecimal and vice-versa using 8085 trainer kit/simulator.
19. Familiarization with 8086 trainer kit, process of storing and viewing of data.
20. Study of 8051 Microcontroller trainer kit/Simulator.
21. Compute an assembly language program to add two 8 bit numbers using 8051 trainer kit/software.
22. Compute an assembly language program to complement a given number using 8051 trainer kit/software.

CO & PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	-	2	1	3	1	1	3	3	1	2
CO 2	3	2	2	3	3	3	1	-	2	1	-	1
CO 3	2	3	3	2	2	3	-	-	2	1	-	1
CO 4	2	1	-	3	2	-	1	-	3	2	-	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	1	3	1
CO 2	-	3	1
CO 3	-	2	3
CO 4	-	2	2

Course Title: Data Structure and Algorithm Lab

Course Code: OE-EE 591A	**Category**: Open Elective Courses
Course Title: Data Structure and Algorithm Lab	**Semester**: 5th
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: Algorithm, Stack, Queue, Recursion, Tree, Graph	
Course Outcomes:	
CO1: Ability to analyze algorithms and algorithm correctness.	
CO2: Ability to summarize searching and sorting techniques.	
CO3: Ability to describe stack, queue and linked list operation.	
CO4: Ability to have knowledge of tree and graphs concepts	

List of Experiments:

1. Implementation of array operation
2. Stack and queue: adding, deleting elements. Circular Queue: adding & deleting elements, Merging problems.
3. Evaluation of expression operation on multiple stack & queues.
4. Implementation of linked lists, inserting, deleting, inverting a linked list, implementation of stacks & queue using linked list.
5. Polynomial addition, Polynomial multiplication
6. Sparse Matrices, Multiplication, addition
7. Recursive and Non-recursive traversal of Trees
8. Threaded binary tree traversal. AVL tree implementation.
9. Application of Trees. Application of sorting and searching algorithm.
10. Hash tables implementation, searching, inserting and deleting, searching & sorting techniques.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	2	2	-	-	-	2	-	3	2
CO 2	2	2	1	1	3	-	-	-	2	-	3	3
CO 3	2	2	2	2	3	-	-	-	3	-	3	3
CO 4	2	2	2	2	3	-	-	-	3	-	3	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	-
CO 2	-	3	2
CO 3	-	3	2
CO 4	2	3	2

Course Title: Electronic Devices Laboratory

Course Code: OE-EE 591B	**Category**: Open Elective Courses
Course Title: Electronic Devices Laboratory	**Semester**: 5th
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: Basic Electronics.	
Course Outcomes:	
CO1: Verify the working of different diodes, transistors, CRO probes and measuring instruments. Identifying the procedure of doing the experiment.	
CO2: Design the circuits with basic semiconductor devices (active & passive elements), measuring instruments & power supplies that serves many practical purposes.	
CO3: Construct, analyze and troubleshoot the designed circuits.	
CO4: Measure and record the experimental data, analyze the results, and prepare a formal laboratory report.	

List of Experiments:

1. V-I Characteristics of PN Junction Diode.
2. V-I Characteristics of Zener Diode and Zener Regulator Characteristics.
3. V-I Characteristics of Led.
4. Half-Wave Rectifier with and without Filter.
5. Full-Wave Rectifier with and without Filter.
6. Measurement of H-Parameters of CB Configuration.
7. Bridge Rectifier with and without Filter.
8. Measurement of H-Parameters of CE Configuration.
9. Drain And Transfer Characteristics of JFET.
10. Frequency Response of CE Amplifier.
11. Frequency Response of FET Amplifier.
12. Comparison of Performance of Self Bias and Fixed Bias.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	0	1	0	2	1	0	2	1	1	2
CO 2	2	1	0	0	1	2	2	2	0	1	0	2
CO 3	2	2	2	2	2	1	0	0	1	0	1	2
CO 4	2	3	3	2	2	1	2	1	0	2	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	-	-
CO 2	2	-	-
CO 3	2	3	2
CO 4	2	3	

Course Title: Communication Engineering Laboratory

Course Code: OE-EE591C	**Category**: Open Elective Courses
Course Title: Communication Engineering Laboratory	**Semester**: 5th
L-T-P :0-0-2	**Credit: 1**

Pre-Requisites: Basic Electronics.
Course Outcomes:
CO1: Develop practical knowledge about theories of analog communication.
CO2: Demonstrate various pulse modulation techniques.
CO3: Evaluate analog modulated waveform in time /frequency domain and also find modulation index.
CO4: Develop understanding about performance of analog and digital communication systems.

List of Experiments:

1. Amplitude modulation and demodulation.
2. Frequency modulation and demodulation.
3. DSB-SC Modulator & Detector.
4. Pulse Amplitude Modulation & Demodulation.
5. Pulse Code Modulation & Demodulation.
6. Time Division Multiplexing & Demultiplexing.
7. Differential Pulse Code Modulation & Demodulation.
8. Delta Modulation.
9. Amplitude Shift Keying.
10. Frequency Shift Keying.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	-	-	-	2	1	-	2	1	1	1
CO 2	1	1	-	-	1	1	2	1	-	1	-	2
CO 3	2	2	2	2	2	1	-	-	1	-	1	1
CO 4	2	3	2	2	2	1	2	1	-	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	-	-
CO 2	2	-	-
CO 3	1	2	2
CO 4	2	1	

Course: Term Paper and Seminar

Course Code: SE-EE581	**Category**: Sessional
Course Title: Term Paper and Seminar	**Semester**: 5th
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: Nil	
Course Outcomes:	
CO1: Understand the relevance of the chosen topic as per his/her program of study in the real world with the help of engineering applications.	
CO2: Illustrate effective presentation skills through his/her presentation style and speaking skills.	
CO3: Demonstrate the knowledge gained during the process of independent study by answering questions based upon his/her study.	
CO4: Write an effective seminar report taking care of professional ethics (like providing references, web links, etc. for any data used in the report).	

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic.
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analyzing each paper.
6. Preparing a working outline.
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation.

Please keep a file where the work carried out by you is maintained. Activities to be carried out.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	1	1	2	3	-	-	3	3	2	2
CO 2	2	2	2	2	2	3	2	2	3	3	3	2
CO 3	2	2	2	3	3	3	3	3	3	3	3	2
CO 4	1	1	1	1	2	3	-	-	3	3	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	3
CO 2	3	3	1
CO 3	3	3	2
CO 4	2	3	3

SEMESTER –VI

Course Title: Power Systems-II

Course Code: PC-EE601	**Category**: Professional Core Courses
Course Title: Power Systems-II	**Semester**: 6th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Power Systems-I, Electrical Machine and Control System, Mathematics, Numerical Methods.	

Course Outcomes:

CO1: Recall the different mathematical and theoretical concepts which can be applied to power generation, transmission and distribution systems.

CO2: Outline the concepts applicable to different areas of power systems and interpret the required modifications to extend them to power system applications.

CO3: Apply the modified concepts to develop the mathematical models of power flow, power system control, stability and economics.

CO4: Inspect the different characteristics of power systems and analyze the effect of their modification on the system state.

Module 1: Fault Analysis (9 hours)
Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding.

Module 2: Power System Protection (7 hours)
Impedance, reactance and Mho Relays, Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Module 3: Stability Constraints in synchronous grids (6 hours)
Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three-phase fault.

Module 4: Control of Frequency and Voltage (7 hours)
Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers, Power Factor Correction.

Module 5: Power System Economics and Management (7 hours)
Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	2	2	2	-	-	2	-	-
CO 2	3	3	3	2	3	2	3	3	-	-	3	3
CO 3	3	3	3	2	3	3	2	3	-	3	-	-
CO 4	3	3	3	3	3	3	3	2	3	2	3	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	3
CO 2	3	2	2
CO 3	3	2	2
CO 4	3	2	3

Text Books:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education,1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education,1995.
3. A.R. Bergen and V. Vittal,“PowerSystemAnalysis”,PearsonEducationInc.,1999.

Reference Books:

1. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
2. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

Course Title: Electric Drives

Course Code: PE-EE601A	**Category**: Professional Elective Courses
Course Title: Electric Drives	**Semester**: 6th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Power Electronics, Electrical Machine and Control System.	
Course Outcomes:	

CO1: Recall the previous knowledge of Power Electronics, Electrical Machines and Control System
CO2: Understand the concepts of dynamic torque, steady state stability and working principle of starting and braking for different electric drive systems like DC motor, three phase Induction motor etc.
CO3: Demonstrate speed control strategies for different electric drive systems, considering factors like torque speed characteristics.
CO4: Analyze the advantages and limitations of different electric drive technologies in specific industrial or automotive applications.
Module 1: Introduction to Electric Drives (8 Hours) Electric Drive: Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load torques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability. Multi-quadrant operation of drives. Load equalization. Motor power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads. Effect of load inertia & environmental factors.
Module 2: Basics of Electric Drives (8 hours) Starting of Electric Drives: Effect of starting on Power supply, motor and load. Methods of starting of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Braking of Electric Drives: Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.
Module 3: DC motor drives (6 hours) Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives.
Module 4: Induction motor drives (6 hours) Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme, Static Scherbius Drive and Static Kramer Drive and their performance and speed-torque characteristics, Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control.

Module 5: Synchronous motor drives (4 hours)
Variable frequency control, Self-Control, Voltage source inverter fed synchronous motor drive, Vector control.

Module 6: Industrial application: (4 hours)
Introduction to Solar and Battery Powered Drive, Introduction to electric vehicle, Stepper motor, Switched Reluctance motor drive, Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	1	-	1	-	2	2	1	2
CO 2	3	3	1	3	2	-	2	-	2	2	2	1
CO 3	2	3	1	2	2	-	-	2	2	2	2	2
CO 4	3	3	2	2	2	2	2	-	1	2	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	2
CO 2	2	2	2
CO 3	2	1	2
CO 4	2	2	1

Text Books:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH.
3. A first course on Electrical Drives, S.K. Pillai, , New Age International Publication.

Reference Books:

1. Electric motor drives, R. Krishnan, PHI.
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

Course Title: Static Control of A.C & D.C Drives

Course Code: PE-EE601B	**Category**: Professional Elective Courses
Course Title: Static Control of A.C & D.C Drives	**Semester**: 6th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Power Electronics, Electrical Machine and Control System.	

Course Outcomes:

CO1:Identify and Analyze Single phase and three phase semi and full converters fed DC Motors to achieve efficient performance for various application.

CO2:Identify and Analyze Dual Converter fed DC Motors to achieve Motoring and Braking operation.

CO3: Implement high performance Induction Motor Drives using principle of vector control.

CO4: Apply the modes of variable frequency control for Synchronous Motor Drives employing Inverters.

Module 1: Single Phase & Dual Converter Drives(10 hours)

Performance parameters, Operation of Full converter and Semi – converter fed separately excited D.C. motors and D.C. series motors, Speed-torque characteristics, Performance characteristics, Comparison, Three Phase Drives, Principle and operation.

Dual Converter Drives: Ideal dual converter and Firing control scheme, Non-ideal dual converter – Without circulating Current, Control strategies, with circulating current – Closed loop system, Dual mode dual converter, PWM Control, Reversible drives – Armature current reversal and Field current reversal.

Module 2: Choppers Drives (8 hours)

One quadrant, two quadrant choppers and four quadrant d.c drives, Analysis, Design of input filter, Multiphase choppers, Dynamic braking and Regenerative braking of phase-controlled drives and chopper drives.

Closed Loop Control: Single phase D.C. drive with dynamic braking, Three-phase dual converter reversible drive, Speed control with inner current loop & field weakening, Phase locked loop control, Microcomputer control.

Module 3: Static Control of Induction Motor Drives(6 hours) Stator Voltage Control, Static rotor resistance control, Slip power recovery schemes – Static Krammer drive, Static Scherbius drive, Closed loop control of the above schemes.
Module 4: Inverter Fed Induction Motor Drives(6 hours) Voltage Source Inverter and Current Source Inverter fed Induction motors, Analysis of Stepped waveform and PWM waveform, Harmonic equivalent circuit and motor performance.
Module 5: Static Control of Synchronous Drives (6 hours) Self-control and Separate control of synchronous motor fed from VSI, Cyclo-converter fed self-control of synchronous motor, CSI fed synchronous motor drive, LCI self-controlled synchronous motor.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	2	2	1	-	1	-	2	1	1	2
CO 2	3	2	1	3	2	-	1	-	1	1	2	1
CO 3	2	2	1	2	2	-	-	2	2	2	1	2
CO 4	3	2	2	2	2	2	2	-	1	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	2
CO 2	2	2	1
CO 3	3	1	2
CO 4	2	2	1

Text Books:

1. G. K. Dubey, Power Semi-Converter Controlled Drives, Prentice Hall, Eaglewood, Cliffs,1989. Electric Drives, Vedam Subrahmanyam, TMH.
2. R. Krishrian, Electric Motor Drives, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.

Reference Books:

1. Sen P.C, Power Electronics, Tata McGraw Hill Pvt. Ltd., New Delhi. Modern Power Electronics & Acdrives, B.K. Bose, Pearson Education.
2. W. Shepard, LN. Hulley and D. T. W. Liang, Power Electronics and Motor Control, Cambridge University Press, 1995.

Course Title: High Voltage Engineering

Course Code: PE-EE 602A	**Category**: Professional Elective Courses
Course Title: High Voltage Engineering	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Power System, Basic Electrical Engineering, Control System.	

Course Outcomes:

CO1: Understand the different physical processes, importance and breakdown phenomenon in dielectrics involved in operation of high voltage systems.

CO2: Illustrate different methods for generation of high voltage schemes.

CO3: Develop different measuring schemes to measure high voltages following the basic standards.

CO4: Analyze and examine the parameters from HV generation scheme to meet design aspect requirements.

Module 1: Breakdown phenomena (12 hours)

Breakdown of Gasses: Mechanism of Breakdown of gasses, Charge multiplication, Secondary emission, Townsend Theory, Streamer Theory, Paschen's Law, Determination of Minimum breakdown voltage, Breakdown in non-uniform field, Effect of polarity on corona inception and break down voltage.

Partial Discharge: definition and development in solid dielectric.

Break Down of Solids: Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Streamer Breakdown.

Breakdown of Liquid: Intrinsic Breakdown, Cavitation Theory, Suspended Particle Theory. Breakdown in Vacuum: Nonmetallic electron emission mechanism, Clump mechanism, Effect of pressure on breakdown voltage.

Module 2: Generation of High Voltage (8 hours)

Generation of high AC voltages: Testing transformer, Cascaded transformer, Series resonant circuit, single stage and multi stage. Advantages of Series Resonant Circuit in testing of cables.

Generation of DC high voltage: Cockcroft Walton doubler and multistage circuit. Electrostatic generator.

Definition of Impulse Voltage as per Indian Standard Specification, wave front and wave tail time, Generation of Impulse Voltage, Multistage Impulse generator, triggering of Impulse Generator.

Module 3: Measurement of High Voltage (6 hours)

Sphere gap voltmeter, AC, DC and impulse high voltage measurement as per Indian Standard Specifications. Resistance and Capacitance Potential dividers, Peak voltmeters for measurement of high AC voltage in conjunction with capacitance dividers. Capacitance Voltage Transformer, Rotating Voltmeter for the measurement of DC high voltage, Electrostatic Voltmeter

Module 4: Transient in power systems (6 hours)

Lightning Phenomena, Electrification of cloud, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke.

Protection of Electrical Apparatus against over voltage, Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Ground wires.

Insulation Coordination, Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.

Module 5: High Voltage Testing (4hours)

High Voltage testing, Testing as per Indian Standard Specifications, Power frequency withstand, induced over voltage and impulse test on transformers, Power frequency wet withstand test and impulse test on insulators

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	-	1	-	-	-	-	-	-	-	-
CO 2	3	3	3	3	3	1	-	-	3	-	-	-
CO 3	3	2	3	3	3	1	-	-	-	2	1	2
CO 4	3	2	3	-	2	2	2	-	2	1	1	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	3	3	-
CO 3	3	3	-
CO 4	3	1	2

Text Books:

1. High Voltage Engineering, C.L. Wadhawa, New Age International Publishers.
2. High Voltage Engineering, M.S. Naidu & V. Kamraju, Tata MC Graw Hill publication.

Reference Books:

1. High-voltage Engineering, E. Kuffel, W. S. Zaengl, Pregamon Press,
2. High Voltage Engineering, M.A. Salem, H. Anis, A. E. Morahedy, R. Radwan, Marcel Dekker, Inc.

Course Title: Utilization of Electric power

Course Code: PE-EE602B	**Category**: Professional Elective Courses
Course Title: Utilization of Electric power	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic knowledge on Electric Machine, Power system analysis, Basic concepts of different laws on Electrostatic and Electromagnetism.	
Course Outcomes:	
CO1: Investigate on the various essential requirements and acquire the ability to design a safe and cost-effective electric traction system	
CO2: Analyze the suitability of different motor drives to be used for a specific purpose and control the operation of various electric appliances used	
CO3: Develop select, and apply appropriate techniques for designing indoor & outdoor lighting schemes	
CO4: Create select, and apply appropriate techniques, tools and resources in designing/developing electrolytic and electrometallurgical processes	
Module 1: Electric Traction-I (8 hours) Introduction: Systems of Electric Traction. Comparison Between A.C And D.C Traction, Special Features of Traction Motors, The Locomotive, Wheel arrangement and Riding Qualities, Transmission of Drive, Characteristics and Control of Locomotives and Motor Coaches for Track Electrification, DC Equipment, AC Equipment, Electric Braking with DC Motors and with AC Motors, Control Gear, Auxiliary Equipment, Track Equipment and Collector Gear, Conductor-Rail Equipment, Overhead Equipment, Collector Gear for Overhead Equipment.	

Module 2:Electric Traction-II (10 hours)

Mechanics of Train Movement. Speed-Time Curves of Different Services, Trapezoidal and Quadrilateral, Speed-Time Curves, Numerical Problems. Calculations of Tractive Effort, Power, Specific Energy Consumption, Effect of Varying Acceleration and Braking Retardation, Adhesive Weight and Coefficient of Adhesion – Problems.

Module 3: Illumination (8 hours)

Definition, Laws of Illumination, Polar Curves, Calculation of MHCP and MSCP. Requirement of Good Lighting Scheme – Types, Design and Calculation of Illumination. Street Lighting and Factory Lighting, Numerical Problems. Lamps: Incandescent Lamp, Sodium Vapour Lamp, Fluorescent Lamp, CFL and LED.

Module 4: Electric Heating, Welding and electrolysis (10 hours)

Electrical Heating: Advantages. Methods of Electric Heating - Resistance, Arc, Induction and Dielectric Heating.

Electric Welding: Types - Resistance, Electric Arc, Gas Welding. Ultrasonic, Welding Electrodes of Various Metals, Defects in Welding.

Electrolysis - Faraday's Laws, Applications of Electrolysis, Power Supply for Electrolysis.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	1	-	1	-	2	2	1	2
CO 2	3	3	1	3	2	-	1	-	2	2	2	1
CO 3	3	3	1	2	2	-	-	2	2	2	2	2
CO 4	2	3	2	2	2	2	2	-	1	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	2
CO 2	2	2	2
CO 3	2	1	2
CO 4	2	2	1

Text Books:

1. Generation Distribution and Utilization of Electrical Energy, C.L. Wadhawa, New Age International Publishers.
2. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.

Reference Books:

1. Utilization of Electric Energy, E.Openahaw Taylor, Orient Longman.

Course Title: Mechatronics and Robotics

Course Code: PE-EE602C	**Category**: Professional Elective Courses
Course Title: Mechatronics and Robotics	**Semester**: 6th
L-T-P:3-1-0	**Credit: 3**
Pre-Requisites: Measurement, Control System	

Course Outcomes:

CO1: Define the open-loop and closed-loop mechatronic systems.

CO2: Explain electrical systems, mechanical switches, solid-state switches.

CO3: Explain the robot configuration and robot motion.

CO4: Analyze the cognitive architecture for cyber-physical robotics and industrial robotic applications.

Module 1: Introduction (10 hours)
Introduction to Mechatronics and Robotics: open-loop and closed-loop mechatronic systems. Classification based on robotics configuration: polar cylindrical, Cartesian coordinate and spherical. Application, Advantages and disadvantages. Automation in industry:Definition, types – Fixed, programmable and flexible automation, basic elements with block diagrams, advantages.

Module 2: Electrical Actuation Systems (8 hours)
Electrical systems, Mechanical switches, solid-state switches, solenoids, DC &AC motors, Stepper motors and their merits and demerits. Signal Conditioning:Introduction to signal conditioning. The operational amplifier.

Module 3: Introduction To Robotics(8 hours)
Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, sensor, robot applications. Kinematic Analysis – Direct and Inverse Kinematic analysis, numerical problems.

Module 4:Advances in Robotics(10 hours)

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	1	-	-	-	-	-	-	-	2
CO 2	2	2	2	1	1	1	2	-	-	-	-	2
CO 3	2	-	1	-	-	2	1	-	-	-	-	2
CO 4	1	1	1	1	-	1	1	-	-	-	-	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	-
CO 2	2	1	1
CO 3	1	-	1
CO 4	1	1	1

Text Books:

1.A Kuttan, “Introduction to Mechatronics, Oxford University Press, 2010.
2. Alciatore& Histand, “Introduction to Mechatronics & Measurement Systems, 4e”, McGrawHill Education, 2014.
3. Power System Analysis, Granger and Stevension, Mc Graw Hill.
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee "Robotics: control, sensing, vision and intelligence", Tata McGraw-Hill, 2008.

Reference Books:

1.Dan Necsulesu, “Mechatronics”, Pearson Education Asia, 2002 (Indian Reprint).
2. NitaigourPremchand Mahadik, “Mechatronics”, McGraw-Hill Education, 2015.

Course Title: Electrical and Hybrid Vehicles

Course Code: PE-EE 602D	**Category**: Professional Elective Courses
Course Title: Electrical and Hybrid Vehicles	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Power Electronics and machines	
Course Outcomes:	
CO1: To understand about basics of hybrid electric vehicle	
CO2: To understand about drives and control.	
CO3: Select battery, battery indication system for EV applications.	
CO4: Design battery charger for an EV.	
Module 1: – Introduction to Hybrid Electric Vehicle (6 hours) Review of Conventional Vehicle: Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving	
Module 2: Electric Drives (8 hours) Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor	
Module 3:Energy Storage (8 hours) Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system, Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle	
Module 4:Energy Management System (7 hours) Energy Management Strategies, Automotive networking and communication, EV charging standards, V2G, G2V, V2B, V2H. Business: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges	

Module 5: Mobility and Connectors (7 hours)

Connected Mobility and Autonomous Mobility- case study Emobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs. **Connectors-** Types of EV charging connector, North American EV Plug Standards, DC Fast Charge EV Plug Standards in North America, CCS (Combined Charging System), CHAdeMO, Tesla, European EV Plug Standards

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	1	3	2	2	1	2	1	1
CO 2	2	3	2	2	1	2	2	3	2	1	2	2
CO 3	3	1	2	2	3	2	3	1	2	2	1	2
CO 4	2	3	2	2	2	2	1	1	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	2	2
CO 3	2	2	1
CO 4	1	1	2

Text Books:

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003.
2. Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.
3. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.

Reference Books:

1. Tariq Muneer and Irene Illescas García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017.
2. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.

Course Title: Database Management Systems

Course Code: OE-EE601A	**Category**: Open Elective Courses
Course Title: Database Management Systems	**Semester**: 6th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: DBMS and computer knowledge	
Course Outcomes:	
CO1: Describe the fundamental elements of relational database management systems.	
CO2: Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.	
CO3: Design ER-models to represent simple database application scenarios.	
CO4: Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data and familiar with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree and hashing.	
Module 1: Introduction (4 hours) Concept & Overview of DBMS, Data model, Database language, Database administrator, Database users, Three Schema architecture of DBMS.	
Module 2: Entity-Relationship Model (5 Hours) Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity sets, Extended E-R features.	
Module 3: Relational Model (5 Hours) Structure of relational Databases, Relational Algebra, Relational calculus, Extended Relational Algebra operations, Views, Modification of the Database.	
Module 4: SQL and Integrity Constraints (6 Hours) Concept of DDL, DML, DCL. Basic structure, Set operations, Aggregate functions, Null values, Domain constraints, Referential integrity, Constraints, assertions, views, Nested sub queries, Data base security application development using SQL, Stored procedures and triggers.	
Module 5: Relational Database design (6 Hours) Functional dependency, Different anomalies in designing a Database, Normalization using functional dependencies, Decomposition, Boyce-Codd normal form, 3NF, Normalization using multi-valued	

dependencies, 4NF, 5 NF.
Module 6: Internal of RDBMS (5 Hours) Physical data structures, Query optimization: join algorithm, statistics and cost base optimization, Transaction processing, Concurrency control and recovery management: transaction model properties, state serializability, look base protocols, two phase locking.
Module 7: File organization & index structures (5 Hours) File & records concepts, Placing file records on disk, Fixed and variable sized records, Types of single –Level index (primary. Secondary, clustering), Multilevel Indexes, Dynamic multilevel indexes using B tree and B+ tree.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	1	1	1	1	1	1	1	1	1	1
CO 2	2	2	2	1	2	2	1	1	2	1	1	3
CO 3	1	2	3	1	2	2	2	2	2	2	2	2
CO 4	1	3	2	3	2	2	2	2	2	3	3	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	1	1	2
CO 2	2	2	1
CO 3	2	2	2
CO 4	1	2	1

Text Books:

1. Database System Concepts, F. Henry & Abraham Silderscharz, Mc Graw Hill.
2. Database Management system, Ramakrishnan, Mc Graw Hill.
3. Principles of Database Systems, J.D. Ullman, Galgotia Publication.

Reference Books:

1. Principles of Database Management Systems. Martin James. PHI.
2. Database management Systems, A.K. Majumder &Pritimay Bhattacharya, Tata McGraw Hill.

Course Title: Embedded Systems

Course Code: OE-EE601B	**Category**: Open Elective Courses
Course Title: Embedded Systems	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Microprocessor, Microcontroller.	

Course Outcomes:

CO1: Discuss different techniques of microprocessor, microcontroller and embedded system.

CO2: Explain different methods of embedded systems.

CO3: Solve the problem of microprocessor, microcontroller and embedded system.

CO4: Analyze various types of disturbances of embedded systems.

Module 1: Introduction to Embedded systems (8 hours)
Introduction – Features – Microprocessors – ALU - Von Neumann and Harvard Architecture - CISC and RISC - Instruction pipelining.
Microcontroller: characteristics and Features, Overview and architectures of Atmel 89C52 and Microchip PIC16F877 and 18F452.
Examples of embedded Systems: Bar-code scanner, Laser printer, Underground tank monitoring.

Module2: PIC Microcontroller (8 hours)
PIC Microcontrollers: 16F877 Architecture and Instruction Set. External Interrupts, Timers, watch-dog timer, I/O port Expansion, analog-to-digital converter, UART, I2C and SPI Bus for Peripheral Chips, Accessories and special features

Module 3: Software architecture and RTOS (6 hours)
Software Architecture: Round Robin- Round Robin with interrupts -Function Queue.
Scheduling Architecture RTOS: Architecture -Tasks and Task States -Tasks and Data -Semaphores and Shared Data - Message Queues -Mail Boxes and pipes -Timer Functions -Events -Memory Management Interrupt Routines.

Module4: Basic design using a real time operating system (6 hours)
Overview. General principles. Design of an embedded system.

Module5: Software development tools and debugging techniques (8 hours)
Development Tool: Cross-Compiler, Cross-Assemblers, Linker/locator. PROM Programmers, ROM Emulator, In-Circuit Emulators. Debugging Techniques. Instruction set simulators. The assert macro. Testing using laboratory tools.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	1	1	-	-	1	-	2	1	1	2
CO 2	2	1	-	-	1	2	2	2	-	1	1	3
CO 3	2	3	2	2	2	1	1	-	1	1	1	-
CO 4	1	1	3	1	3	2	2	1	1	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	-
CO 2	2	2	-
CO 3	2	1	1
CO 4	2	2	1

Text Books:

1. Embedded Systems Architecture, Programming and Design, Ral KamalTMH, 2008.
2. An Embedded Software Primer, D.E. Simon. Pearson Education, 1999.
3. Design with PIC Microcontrollers, J.B. Peatman,Pearson Education, 1998.

Reference Books:

1. Embedded Systems Design, Heath Steve, Second Edition-2003.
2. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001.
3. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002.

Course Title: Data Analytics with Python

Course Code: OE-EE601C	**Category**: Open Elective Courses
Course Title: Data Analytics with Python	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic Computer.	

Course Outcomes:

CO1: Discuss different techniques of data science.

CO2: Explain python for data science.

CO3: Solve the problem using data science.

CO4: Analyze data operations with Numpy and Pandas.

Module 1: Data Science Fundamentals (8 hours)
Thought Experiment: Data Science from a layman's perspective, Brief intro to Data Science, How companies use Data Science, Overview of Data Science project lifecycle, Walkthrough of data types and data challenges.

Module: 2 Python for Data Science(8 hours)
Python for Data Science, In-class quiz for Python Basics, Common Python concepts and sample questions, Variable, Inbuilt datatypes, functions, modules and Packages, File operations and error handling.

Module: 3 Statistics for Data Science(6 hours)
Statistics for Data Science, In-class quiz for Descriptive Statistics, Common charts used, In-class quiz for Inferential Statistics, Probability, Central Limit Theorem, Normal Distribution & Hypothesis testing.

Module: 4 Data Operations with Numpy(6 hours)
Data Operations with Numpy, Introduction to Numpy Arrays, How to apply mathematical operations in Numpy, Array manipulation using Numpy, Broadcast values across Arrays using Numpy.

Module: 5 Data Manipulation with Pandas (8 hours)
Types of Data Structures in Pandas, Clean data using Pandas, Manipulating data in Pandas, How to deal with missing values, Hands-on: Implement Numpy arrays and Pandas Dataframes.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	1	1	-	-	1	-	2	1	1	2
CO 2	2	1	-	-	1	2	2	2	-	1	1	3
CO 3	2	3	2	2	2	1	1	-	1	1	1	-
CO 4	1	1	3	1	3	2	2	1	1	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	-
CO 2	2	2	-
CO 3	2	1	1
CO 4	2	2	1

Text Books:

1. Python Data Science Handbook: Essential Tools for Working with Data, Second Edition, Jake VanderPlas, (Grayscale Indian Edition), 2022.
2. Data Science and Machine Learning using Python, Jake VanderPlas, 2022.

Reference Books:

1. Ultimate Data Science Programming in Python: Saurabh Chandrakar, 2024.

Course Title: Computer Networking

Course Code: **OE-EE 602A**	**Category**: Open Elective Courses
Course Title: Computer Networking	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Computer Knowledge, Hardware and software network	
Course Outcomes:	

CO1: Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
CO2: Have a basic knowledge of the use of cryptography and network security.
CO3: Specify and identify deficiencies in existing protocols, and then go onto formulate new and better protocols.
CO4: Have a working knowledge of datagram and internet socket programming.
Module 1: Overview of Data Communication and Networking (10 hours) Introduction, Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN,WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study. **Physical Level:** Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit Switching: time division & space division switch, TDM bus; Telephone Network.
Module 2: Data link Layer and Medium Access sub layer (10 hours) Types of errors, framing (character and bit stuffing), error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, Go-Back-N ARQ, Selective repeat ARQ, HDLC;] **Medium Access sublayer:** Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, fast Ethernet (in brief).
Module 3: Network layer and Transport layer (12 hours) Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, subnetting; Routing : techniques, static vs. dynamic routing , Unicast Routing Protocols: RIP, OSPF, BGP; Other Protocols: ARP, IP, ICMP, IPV6. **Transport layer:** Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm,

Module 4:Application Layer and Modern topics (4 hours)

Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW; Security: Cryptography (Public, Private Key based), Digital Signature, Firewalls.

Modern topics:

ISDN services & ATM, DSL technology, Cable Modem: Architecture and operation in brief. Wireless LAN: IEEE 802.11, Introduction to blue-tooth.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	1	1	2	2	-	-	-	2	-	3	2
CO 2	2	2	1	1	3	-	-	-	2	-	3	3
CO 3	2	2	2	2	3	-	-	-	3	-	3	3
CO 4	2	2	2	2	3	-	-	-	3	-	3	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	-
CO 2	-	3	2
CO 3	-	3	2
CO 4	2	3	2

Text Books:

1. Data Communications and Networking (3rd Ed.), A. Forouzan, TMH.
2. Computer Networks (4th Ed.), A. S. Tanenbaum, Pearson Education/PHI.
3. Data and Computer Communications (5th Ed.), W. Stallings, PHI/ Pearson Education.

Reference Books:

1. Computer Networking -A top down approach featuring the internet, Kurose and RosePearson Education.
2. Communication Networks, Leon, Garica, Widjaja, TMHCommunication Networks, Walrand, TMH.

Course Title: Artificial Intelligence and Machine Learning

Course Code: OE-EE602B	**Category**: Open Elective Courses
Course Title: Artificial Intelligence and Machine Learning	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic math, Science and Computer programming.	

Course Outcomes:

CO1: Remember various problem-solving techniques for solving different algorithms.

CO2: Interpret these algorithms in applications which involve perception, reasoning and learning.

CO3: Apply different learning techniques to understand the relation to the environment and the way of evaluation.

CO4: Analyze the concept of real-world knowledge representation.

Module 1: Introduction to AI (6 hours)
Define Artificial Intelligence, Define AI techniques, Problem solving using state space search, apply Heuristics, Hill climbing, Search using BFS, DFS.

Module 2: Knowledge representation and Logic Programming (6 hours)
Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural Vs Declarative knowledge, Forward Vs Backward reasoning, Logic Programming-predicate Logic.

Module 3: Mathematical foundation (6 hours)
Matrix Theory and Statics for Machine Learning. Idea of Machine learning from data, Classification of problem- Regression and Classification Supervised and Unsupervised learning.

Module 4:Linear Regression (6 hours)
Model representation of single variable, Single variable cost function, Gradient Decent for Linear Regression, Gradient Decent in practice.

Module 5: Logistic Regression (4 hours)
Classifications, Hypothesis Representation, Decision Boundary, Cost Function, Advanced Optimization, Multi-classification (one Vs all), Problem Over fitting.

Module 6: Supervised and Unsupervised Learning (4 hours)
Decision on Clustering and Classification algorithms, Naïve Bayes Theorem, Decision Tree, SVM.

Module 7:Applications (4 hours)
Communication: Communication as action, Formal grammar for a fragment of English, Syntactic analysis, Augmented grammars, Semantic interpretation, Ambiguity and disambiguation, Discourse understanding, Grammar induction, Probabilistic language processing, Probabilistic language models, Information retrieval, Information Extraction, Machine translation.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	2	2	0	3	2	2	1	2	2	2
CO 2	2	1	2	2	2	3	2	2	2	2	2	2
CO 3	2	1	1	2	1	3	2	1	1	2	1	2
CO 4	2	1	1	1	1	3	2	1	2	1	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	1
CO 2	1	2	-
CO 3	1	1	1
CO 4	2	1	1

Text Books:

1. Artificial Intelligence – A Modern Approach", Stuart Russell, Peter Norvig.
2. 2nd Edition, Pearson Education / Prentice Hall of India, 2004.
3. Machine Learning- Tom Mitchel, Packet Publishing Limited, 2017.

Reference Books:

1. Artificial Intelligence: A new Synthesis, Nilsson. J. Nils, Harcourt Asia Pvt. Ltd., 2000.
2. Artificial Intelligence, Rich Elaine & Knight Kevin, 2nd Edition, Tata McGraw-Hill, 2003.
3. Artificial Intelligence-Structures and Strategies for Complex Problem Solving, Geogre F. Luger, Pearson Education / PHI, 2002.

Course Title: Economics for Engineers

Course Code: HM-EE 601	**Category**: Humanities& Social Science Courses
Course Title: Economics for Engineers	**Semester**: 6th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Analytical and Mathematical skills.	

Course Outcomes:

CO1: Recall and explain fundamental concepts of engineering economics.

CO2: Apply economic principles and techniques to analyze engineering projects and make informed decisions based on economic criteria.

CO3: analyze project cost structures, estimate costs using appropriate methods, and evaluate cost-effectiveness of the engineering projects using NPV, IRR, BCR etc.

CO4: Integrate economic sustainability considerations into engineering design and decision-making processes by assessing project risk through sensitivity analysis.

Module 1: Introduction to Engineering Economy (6 hours)
Origin of Engineering Economy, Principles of Engineering Economy, Role of Engineers in Decision Making.

Module 2: Time Value of Money (8 hours)
Introduction to Time Value of Money, Simple Interest, Compound Interest, Nominal Interest rate, Effective Interest rate, Continuous Compounding, Economic Equivalence, Development of Interest Formulas, The Five Types of Cash flows, Single Cash flow Formulas, Uneven Payment Series, Equal Payment Series

Module 3: Methods of comparison of alternatives (8 hours)
NPV, Profitability Index or Benefit Cost Ratio, Payback Period Method, Equivalent Worth Methods, Present Worth Method, Future Worth Method, Annual Worth Method, Rate of Return Methods (IRR and ARR)

Module 4: Engineering Costs & Estimation (6 hours)
Elements of cost (Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring and Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle

Costs) and cost estimation models (Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve), Concept of Revenue, Break even analysis, Cost sheet.

Module 5: Inflation And Price Change (8 hours)

Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	-	1	1	-	-	-	-	-	1
CO 2	2	-	2	-	2	2	2	2	-	1	2	-
CO 3	-	2	2	2	-	1	-	1	-	-	2	-
CO 4	1	-	-	-	3	-	1	-	1	2	1	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	1	-	3
CO 2	-	-	3
CO 3	1	1	3
CO 4	2	-	-

Text Books:

1. Donald Newnan, Ted Eschembach, Jerome Lavelle: Engineering Economics Analysis, OUP.
2. R. Paneer Seelvan: Engineering Economics, PHI.
3. Sullivan and Wicks: Engineering Economy, Pearson.

Reference Books:

1. John A. White, Kenneth E. Case, David B. Pratt : Principle of Engineering Economic Analysis, John Wiley.
2. James L. Riggs, David D. Bedworth, Sabah U. Randhawa: Economics for Engineers 4e,Tata Mc Graw – Hill.

Course Title: Power System-II Laboratory

Course Code: PC-EE 691	**Category:** Professional Core Course
Course Title: Power System-II Laboratory	**Semester**: 6th
L-T-P:0-0-2	**Credit: 1**
Pre-Requisites: Power Systems-I, Electrical Machine and Control System, Mathematics.	
Course Outcomes:	
CO1: Recall mathematical and theoretical concepts that can be applied to develop power systems experiments.	
CO2: Interpret different aspects of power systems and classify the different parameters which can be used to control the operation of power systems.	
CO3: Develop testing and experimental procedures to simulate and verify the theoretical knowledge.	
CO4: Analyze different types of simulations and study the effect of changing different control parameters on the operation of power systems and identify any discrepancy with theoretical knowledge.	

List of Experiments:

1. Study of the characteristics of Overcurrent Relay.
2. Study of the characteristics of Undervoltage and Earth fault relay.
3. Study on Economic Load Dispatch.
4. Transient stability analysis of single machine connected to infinite bus.
5. Voltage control using STATCOM.
6. Study on the reliability of power system using Power world.
7. Automatic Generation Control using Simulink.
8. Active and reactive power control of alternator.
9. Measurement of earth resistance.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	2	2	2	-	-	-	-	-
CO 2	3	2	2	3	2	3	2	2	-	2	-	-

CO 3	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2**
CO 4	**3**	**3**	**2**	**3**	**3**		**3**	**2**	**3**	**-**	**2**	**-**

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	2
CO 2	2	2	3
CO 3	3	1	1
CO 4	2	3	3

Course Title: Electric Drives Laboratory

Course Code: PE-EE691A	**Category:** Professional Elective Courses
Course Title: Electric Drives Laboratory	**Semester**: 6th
L-T-P: 0-0-3	**Credit: 1**
Pre-Requisites: Power Electronics, Electrical Machine and Control System.	
Course Outcomes:	
CO1: Recall relevant information regarding practical approach of Power Electronics, Electrical Machine and Control System to supplement to the Electric Drives course.	
CO2: Understand the need of different instruments with proper range and familiarize with PSIM software for performing experiments on different electric drive systems.	
CO3: Implement control algorithms and tune parameters to achieve desired responses in electric drive systems during practical experiments.	
CO4: Analyze the behavior of electric drive systems under various conditions, identifying issues such as torque ripples and speed fluctuations.	

List of Experiments:

1. Speed control of DC motor using Single phase controlled converter.
2. Speed control of DC motor using dual converter.
3. PWM Inverter fed 3 phase Induction Motor control.

4. Study of Dynamic braking operation for DC Motor using PSIM/MATLAB software.
5. Study of Regenerative braking operation for DC Motor using PSIM/MATLAB software.
6. Study of Single phase controlled converter fed DC Motor using PSIM/MATLAB software.
6. Study of Single phase half controlled converter fed DC Motor using PSIM/MATLAB software.
7. Study of Buck Chopper fed DC Motor using PSIM/MATLAB software.
8. Study of Boost Chopper fed DC Motor using PSIM/MATLAB software.
9. Three phase SPWM inverter fed Three phase induction motor using PSIM/MATLAB software.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	3	1	2	-	1	-	2	-	1	-	3
CO 2	1	3	-	2	3	-	1	2	-	1	1	-
CO 3	2	1	3	2	-	-	3	1	2	1	-	2
CO 4	2	2	2	1	-	2	3	-	-	1	-	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	1
CO 2	2	1	-
CO 3	2	2	-
CO 4	1	2	1

Course Title: Static Control of A.C & D.C Drives Laboratory

Course Code: PE-EE691B	**Category:** Professional Elective Courses
Course Title: Static Control of A.C & D.C Drives Laboratory	**Semester**: 6th
L-T-P: 0-0-3	**Credit: 1**
Pre-Requisites: Power Electronics, Electrical Machine and Control System.	
Course Outcomes:	

CO1: Gain a workable knowledge in analyzing Electric Drive and Control of asystem.
CO2: Analyze the need of different instruments with proper range and familiarize with simulation software for performing experiments on different electric drive systems.
CO3: Analyze the behavior of Power Electronic Circuits.
CO4: Able todesign and analyze different advanced control schemes of D.C and A.C machine.

List of Experiments:

1. Speed control of three-phase induction motor using V/f control.
2. Speed Control of separately excited DC motor using Half ControlledConverter.
3. PWM Inverter fed 3 phase Induction Motor control.
4. Study of Dynamic braking operation for DC Motor using PSIM/MATLAB software.
5. Study of Regenerative braking operation for DC Motor using PSIM/MATLAB software.
6. Speed control of separately excited dc motor by varying armature voltage using single phase Fully Controlled Converter
7. Speed Control of three-phase Slip Ring Induction Motor using Static Rotor Resistance control using Rectifier and Chopper.
8. Study of Buck Chopper fed DC Motor using PSIM/MATLAB software.
9. Three phase SPWM inverter fed Three phase induction motor using PSIM/MATLAB software.
10. Study of Boost Chopper fed DC Motor using PSIM/MATLAB software.

CO & PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	2	1	2	2	-	1	-	2	-	1	-	2
CO 2	1	3	-	1	2	-	1	2	-	1	1	-
CO 3	2	1	2	2	-	-	3	1	2	1	-	2
CO 4	1	2	1	1	-	-	3	-	-	1	-	1

CO & PSO Mapping:

	PSO1	**PSO2**	**PSO3**
CO 1	2	2	1
CO 2	2	1	-
CO 3	1	1	-
CO 4	1	2	1

Course Title: Electrical Systems Design Laboratory

Course Code: PC-EE692	**Category**: Professional Core Courses
Course Title: Electrical Systems Design Laboratory	**Semester**: 6th
L-T-P: 0-0-6	**Credit: 3**
Pre-Requisites: Power System	

Course Outcomes:

CO1: Recall the various concepts and principles of electrical engineering and relate the various design specifications and safety parameters which influence the design.

CO2: Demonstrate the basic steps involved in design of various electrical components, Electrical Layout of power distribution system, residential building and Earthing system.

CO3: Identify the limitations (assumptions) of traditional designs and need for CAD analysis.

CO4:Analyze and adjust the design parameters as per performance and design requirements and complete the design of various electrical components and layouts.

The students would INDIVIDUALLY design the equipment and systems as per specifications provided by the class Teacher following established procedures.
For each student, any three groups can be chosen.
For unspecified items of specification and or specifications of wires, cables etc., data should be taken by students from handbooks and Indian standard.
Students should spend the allotted periods for carrying out design computations. Their attendance shall be recorded.
Students should maintain a dedicated bound notebook for recording design activities like calculations, formulae used, sketches, flowcharts etc. The notebook should be regularly submitted to the class teacher for review and signature.
Evaluation would be based on (i) Class attendance (20%), (ii) Design Notebook (30%) (iii) Design Report (30%) (iv) End of semester viva (20%, preferably by an external examiner)

Group-A
Designing a heating element with specified wattage, voltage and ambient temperature. Designing an air core grounding reactor with specified operating voltage, nominal current and fault current.

Group-B
Designing the power distribution system for a small township.
Designing a double circuit transmission line for a given voltage level and power (MVA) transfer.

Wiring and installation design of a multistoried residential building (G+4 not less than 16 dwelling flats with a lift and common pump)
Designing of a substation

Group-C
General awareness of IS Codes (IS 3043, IS 732, IS2675, IS5216-P12, IS2309),The Indian Electricity Act2003,National Electric Code (NEC2011)-scope and safety aspects applicable to low and medium (domestic) voltage installations, Electric services in buildings, Classification of voltages, standards and specifications.
General aspects of the design of electrical installations for domestic
Dwellings as per NEC guidelines (low and medium voltage installations)–connected load calculation, sub circuit determination, selection of main distribution board, sub distribution board, MCB, ELCB, MCCB and cables for sub circuits. Pre-commissioning tests of domestic installations.

Group-D
Internal Electrification design: Electrical Layout in residential building using Auto CAD, Selection of house wiring, Sizing and Selection of Conduit, Sizing and selection of Switch Socket, Calculation of load on circuit, Design of sub circuit (Lighting Circuit and Power Circuit), Distribution of Power Circuit, Calculation of fan, Calculation of Earthing for residential buildings, Sizing and selection of low voltage switchgears (MCB, MCCB, RCCB, RCBO, MPCB)

Group-E
Earthing Design: Factors Influencing The Choice of Earthed And Unearthed Systems, System Earthing & Equipment Earthing Connections To Earth, Resistance to Earth and Earth Electrode Current Density at The Surface of an Earth Electrode, Selection of an Earthing Conductor and Connection of an Electrode, Typical Schematic of Earthing And Protective Conductors , Calculation of Earth Fault Currents, Measurement of Earth Resistivity , Measurement of Earth Electrode Resistance, Measurement of Earth Loop Impedance

Text Books:

1. Electrical Design Estimating and Costing K.B. Raina, S.K. Bhattacharya, New Age International Publishers.
2. A Course in Electrical Installation Estimating and Costing - J.B. Gupta, Sk Kataria & Sons.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	3	1	2	2	2	2	3	3	2	3
CO 2	2	2	3	3	2	2	2	2	2	2	2	2
CO 3	3	3	3	1	3	3	2	1	2	2	3	2
CO 4	3	3	2	2	3	3	2	2	1	2	3	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	3
CO 2	3	2	3
CO 3	1	2	2
CO 4	2	1	2

Course Title: Database Management Systems Laboratory

Course Code: OE-EE691A	**Category**: Open Elective Courses
Course Title: Database Management Systems Laboratory	**Semester**: 6th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Basic database concepts, applications, data models, schemas and instances	
Course Outcomes:	
CO1: Apply the basic concepts of Database Systems and Applications.	
CO2: Use the basics of SQL and construct queries using SQL in database creation and interaction.	
CO3: Design a commercial relational database system (Oracle, MySQL) by writing SQL using the system.	
CO4: Analyze and Select storage and recovery techniques of database system.	

List of Experiments:

1. Creating Database:
- Creating a Database
- Creating a table
- Specifying Relational Data Types
- Specifying Constraints
- Creating Indexes.
2. Table and record Handling
- INSERT statement
- Using SELECT and INSERT together
- DELETE, UPDATE, TRUNCATE statements
- DROP, ALTER statements
3. Retrieving Data from Database
- The SELECT statement
- Using the WHERE clause
- Using Logical Operators in the WHERE clause
- Using IN, BETWEEN, LIKE, ORDER,BY GROUP BY and HAVING
4. Clause
- Using AGGREGATE function
- Combining Tables using JOINS
- Sub queries
5. Database Management.
- Creating views
- Creating Column Aliases
- Creating Database Users
- Using GRANT and REVOKE

CO & PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	1	1	1	1	1	1	1	1	2	2
CO 2	2	2	2	3	2	1	2	1	2	1	2	2
CO 3	2	2	3	3	3	1	3	1	3	2	3	2
CO 4	1	3	2	2	1	1	3	1	3	3	2	1

CO & PSO Mapping:

	PSO1	**PSO2**	**PSO3**
CO 1	1	1	2
CO 2	2	1	1
CO 3	2	1	2
CO 4	1	3	2

Course Title: Embedded System Laboratory

Course Code: OE-EE691B	**Category**: Open Elective Core Courses
Course Title: Embedded System Laboratory	**Semester**: 6th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Basic Electronics	
Course Outcomes:	
CO1: Write programs in ARM for a specific Application.	
CO2: Interface memory and Write programs related to memory operations.	
CO3: Analyze the performance of interrupt.	
CO4: Formulate a mini project using embedded system.	

List of Experiments:

1. Study of ARM evaluation system.
2. Interfacing ADC and DAC.
3. 3. Interfacing LED and PWM.
4. Interfacing real time clock and serial port.
5. Interfacing keyboard and LCD.
6. Interfacing EPROM and interrupt.
7. Interrupt performance characteristics of ARM and FPGA.
8. Interfacing stepper motor and temperature sensor.
9. Implementing zigbee protocol with ARM.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	-	2	1	-	2	-	3	1
CO 2	3	3	3	3	1	1	-	-	3	-	-	-
CO 3	3	3	2	3	3	-	1	-	2	-	-	-
CO 4	3	2	3	3	2	-	3	-	2	-	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	1	1
CO 2	1	-	1
CO 3	-	1	-
CO 4	-	3	-

Course Title: Data Analytics with Python Laboratory

Course Code: OE-EE691C	**Category:**Open Elective Courses
Course Title: Data Analytics with Python Laboratory	**Semester**: 6th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites:Basic Computer.	
Course Outcomes:	
CO1: Gain a workable knowledge about different techniques of data science.	
CO2: Analyze the need of python for data science.	
CO3: Analyze data operations with Numpy and Pandas.	
CO4: Solve the problem using data science.	

List of Experiments:

1. **Basic Set up**
Tools online for coding
Set-up of Python
After set-up

2. Programming Basic
Hello World
Python Naming convention
Keywords in python
Python basic Syntax
Lines and identation
MultiLine Statement
QuotationComments in Python

3. Assigning Data Types
Data Types and bit calculation
Multiple assignment in Python
Type conversion

4. Operations in Python
Arithmetic Operators
Comparison Operators
Assignment Operators
Logical Operator

Bitwise Operator
Membership Operator
Identity Operator
Precedence of Operatoe

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	1	2	2	-	1	-	2	-	1	-	2
CO 2	1	3	-	1	2	-	1	2	-	1	1	-
CO 3	2	1	2	2	-	-	3	1	2	1	-	2
CO 4	1	2	1	1	-	-	3	-	-	1	-	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	2	1
CO 2	2	1	-
CO 3	1	1	-
CO 4	1	2	1

SEMESTER-VII

Course Title: EHVAC Transmission

Course Code: PE-EE 701A	**Category**: Professional Elective Courses
Course Title: EHVAC Transmission	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic of power system, Generation system, protection system.	

Course Outcomes:

CO1: Acquire knowledge of EHVAC transmission and advantage of EHVAC transmission over conventional AC transmission.

CO2: Formulate and solve mathematical problems related to EHVAC transmission for practical applications.

CO3: Analyze the different voltage gradients of conductors.

CO4: Analyze voltage control using synchronous condensers.

Module 1: INTRODUCTION (8 Hours)
Need of EHV transmission, comparison of EHV AC & HVDC transmission, mechanical considerations of transmission line.

Module 2: EHV AC Transmission(8 Hours)
Parameters of EHV lines, Voltage gradient in bundle conductors lines, conductor sizing, overvoltages due to switching, Ferro resonance. Insulation coordination line insulators and clearances, Corona & its effects, power loss, audible noise and radio-interference, long distance transmission with series and shunt compensations, principle of half wave transmission, flexible ac transmission

Module 3: Voltage gradients of conductors (12 Hours)
Electrostatics field of sphere gap, field of line changes and properties, charge, potential relations for multi-conductors, surface voltage gradient on conductors, distribution of voltage gradient on sub conductors of bundle.
Electrostatic field: calculation of electrostatic field of EHV/AC lines, effect on humans, animals and plants, electrostatic induction in un-energized circuit of double-circuit line, electromagnetic interference

Module 4: Voltage control(8 Hours)

Power circle diagram and its use voltage control using synchronous condensers, cascade connection of shunt and series compensation, sub synchronous resonance in series capacitor, compensated lines, static VAR compensating system.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	2	2	-	2	1	-	2	-	3	1
CO 2	3	3	3	3	1	1	-	-	3	-	-	-
CO 3	3	3	2	3	3	-	1	-	2	-	-	-
CO 4	3	2	3	3	2	-	3	-	2	-	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	-	-
CO 2	3	2	1
CO 3	3	2	1
CO 4	3	2	1

Text Books:

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering” Revised Second Edition, John Wiley.
2. Padiyar K R “FACTS controllers in Power Transmission and distribution” New Delhi, New Age Int.
3. EHVAC and HVDC Transmission Engineering and Practice –S.Rao.

Reference Books:

1. The Performance, Operation and Control of EHV Power Transmission Systems, A. Chakraborty, D.P.Kothary, A.K. Mukhopadhyay, Wheeler Pub.

Course Title: Electrical energy Conservation and Auditing

Course Code: PE-EE701B	**Category**: Professional Elective Courses
Course Title: Electrical Energy Conservation and Auditing	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic understanding about energy consumption patterns.	

Course Outcomes:
CO1: Recall the key concepts of energy generation, consumption and economics.
CO2: Explain the principles of energy consumption and efficiency and interpret the relationship between energy management and sustainable practices
CO3: Develop knowledge on the present energy environment scenario, energy conservation regulations and environmental effects of different energy generating sources
CO4: Evaluate the economic feasibility of energy saving initiatives and analyze the impact of energy management on sustainable development
Module 1: Energy Management & Audit (4 hours) Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments and intervals of EA regulation.
Module 2: Energy Scenario (8 hours) Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Concept of smart grid, Tariff.
Module 3: Energy Conservation Act-2001 and related policies (6 hours) Energy Conservation Act-2001 and its features, Notification Under the act, Designated agencies, Schemes of Bureau of Energy Efficiency (BEE)-ECBC, S & L, DSM, BLY, SME's, Designated Consumers, Electricity Act 2003, Integrated Energy Policy.
Module 4: Energy Efficiency and Climate changes (6 hours) Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures, Sustainable development Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures, Sustainable development.
Module 5: Non-Conventional Energy Sources (6 hours) Concept of renewable Energy and importance, Different types of renewable Energy, Solar energy, Wind energy, Biomass energy, Hydro-energy, Fuel cells, Energy from wastes, Wave, Tidal and geothermal. Concept of energy storing device.

Module 6: Energy Efficient Technologies in Electrical Systems (6 hours)
Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	3	1	-	-	2	1	1	-	-	-
CO 2	2	2	3	3	2	2	1	1	-	-	-	-
CO 3	3	3	3	1	-	1	-	-	-	1	-	1
CO 4	3	3	2	2	1	-	-	-	1	1	1	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	-	2
CO 2	3	-	2
CO 3	3	3	-
CO 4	3	3	-

Text Books:

1. Energy Management Supply and Conservation, Dr. Clive Beggs, Butterworth Heinemann, 2002.
2. Handbook of Energy Engineering, Albert Thumann & Paul Mehta, The Fairmont Press, INC.
3. Plant Engineers & Manager Guide to Energy Conservation, Albert.
4. Energy Management Handbook, Wayne C, John Willey and Sons

Reference Books:

1. NPC energy audit manual and reports
2. Guide to Energy Management, Cape Hart, Turner and Kennedy
3. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council
4. www.bee.org

Course Title: Power Quality and FACTS

Course Code: PE-EE701C	**Category**: Professional Elective Courses
Course Title: Power Quality and Facts	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Power System, Synchronous Machines.	
Course Outcomes:	
CO1: Understand the major power quality problems.	

CO2: Understand and analyze harmonics in power systems.
CO3: Use equipment that are required to measure the quality of power.
CO4: Understand FACTS devices and analyze reactive power requirement and management.
Module 1: Introduction To Power Quality and Power Quality Problems in Distribution Systems (8 hours) Terms and definitions & Sources – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Sags and swells - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuations - Power frequency variations - International standards of power quality – Computer Business Equipment Manufacturers Associations (CBEMA) curve. Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement.
Module 2: Harmonics (8 hours) Harmonic sources from commercial and industrial loads - Locating harmonic sources – Power system response characteristics - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortions - Harmonic indices - Inter harmonics – Resonance Harmonic distortion evaluation, IEEE and IEC standards.
Module 3: Static Shunt Compensators and Static Series Compensators (8 hours) Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics **Static Series Compensators:** Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control
Module 4: Static Voltage and Phase Angle Regulators: TCVR and TCPAR, UPFC (12 hours) Static Voltage and Phase Angle Regulators: TCVR and TCPAR. Unified power flow controllers

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	3	1	-	-	2	2	1	-	1	2
CO 2	2	2	3	3	2	2	1	2	3	2	3	1
CO 3	3	3	3	1	-	1	-	3	1	-	1	-
CO 4	3	3	2	2	1	-	-	3	2	1	2	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	1	-
CO 2	3	3	1
CO 3	3	1	-
CO 4	2	2	1

Text Books:

1.J.Arillaga, N.R.Watson and S.Chen, "Power System Quality Assessment", John Wiley & Sons, England, 2000.
2. Math J.Bollen, "Understanding Power Quality Problems-Voltage Sags and Interruptions", John Wiley & Sons, New Jersey, 2000.
3. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, "Power Quality: Problems and mitigation Techniques", Wiley 2015.

References Books:

1. Electrical Power Systems Quality, Dugan Roger C, Santoso Surya, Mc Granaghan, Marks F. Beaty and H. Wayre, Mc Graw Hill.
2. Power Systems Quality Assessment, J. Arillaga, N.R. Watson, S.Clon, John Wiley.
3. Understanding FACTS by Narain G. Hingorani & Laszlo Gyugyi: IEEE Press. 2. Power System Switchgear & Protection by Sunil S. Rao.

Course Title: Power Quality and FACTS

Course Code: PE-EE701D	**Category**: Professional Elective Courses
Course Title: Renewable Energy	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Power Systems.	
Course Outcomes:	
CO1: Remember the different sources of energy prevailing around the globe to generate power.	
CO2: Explainthe different forms of renewable and non-renewable energy used to harness power using modern technology.	
CO3: Apply the technical skills and methodology to design renewable energy plant layout.	
CO4: Analyze different dynamic parameters of renewable energy plants for further development and expansion of the plant.	
Module 1: Introduction to Energy sources (4 hours) Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on the environment, Kyoto Protocol.	
Module 2: Solar Energy (6 hours) Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length.	

flat plate collectors, concentrating collectors, Solar air heaters-types, solar dryers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photovoltaic - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems.

Module 3: Wind Energy (6 hours)

Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations

Module 4: Energy from Biomass, Geothermal, Ocean,MHD, Hydrogen, Fuel Cell(20 hours)

Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.

Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.

Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	3	1	-	-	2	2	1	-	1	2
CO 2	2	2	3	3	2	2	1	2	3	2	3	1
CO 3	3	3	3	1	-	1	-	3	1	-	1	-
CO 4	3	3	2	2	1	-	-	3	2	1	2	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	1	-
CO 2	3	3	1
CO 3	3	1	-
CO 4	2	2	1

Text Books:

1.Non conventional Energy sources, G.D. Rai, Khanna Publishers.

2. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.

3. Non conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.

References Books:

1. Renewable energy resources and emerging technologies, D.P. Kothari, Prentice Hall of Page | 126 India Pvt. Ltd.

Course Title: Power Plant Engineering

Course Code: OE-EE702A	**Category**: Open Elective Courses
Course Title: Power Plant Engineering	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Engineering Thermodynamics, Thermal Power Engineering	
Course Outcomes:	
CO1: Recall the mathematical operations and thermodynamic principles of combustion and power generation.	
CO2: Interpret the operation and economics of power plant equipment and power generation methods based on basic principles.	
CO3: Develop mathematical equations and layout diagrams of different power plant equipment and systems with their operations.	
CO4: Inspect the application of different power plant systems and equipment with their performance analysis.	
Module 1: Introduction (6 hours) Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant.	

Power plant economics and selection:
Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.

Module 2: Steam power plant (6 hours)

General layout of steam power plant, Power plant boilers including critical and supercritical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizes and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant

Module 3: Diesel power plant (8 hours)

General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.

Gas turbine power plant:

Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant.

Module 4:Nuclear power plant (8 hours)

Principles of nuclear energy, Layout of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants.
Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems.
Non Conventional Power Plants Introduction to non-conventional power plants (Solar, wind, geothermal, tidal) etc.

Module 5: Electrical system (8 hours)

Generators and their cooling, transformers and their cooling.
Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms. Pollution due to power generation.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	2	2	2	2	-	-	2	-	-
CO 2	3	3	3	2	2	2	2	3	-	-	3	3
CO 3	3	3	3	2	3	3	2	3	-	3	-	-
CO 4	3	3	3	3	3	3	3	2	3	2	3	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	-	2
CO 2	1	2	3
CO 3	1	2	2
CO 4	2	2	3

Text Books:

1. Power Plant Engineering, P.K. Nag, Tata McGraw Hill.
2. Power Plant Engineering, F.T. Morse, Affiliated East-West Press Pvt. Ltd, New Delhi/Madras
3. Power Plant Technology El-Vakil, McGraw Hill.

Reference Books:

1. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub. House.

Course Title: Power Plant Instrumentation and Control

Course Code: OE-EE702B	**Category**: Open Elective Courses
Course Title: Power Plant Instrumentation and Control	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Measurement and Instrumentation, Control System, Power Plant Engineering.	
Course Outcomes:	
CO1: To provide an overview of different methods of power generation with a particular stress on	

thermal power generation.
CO2: To bring out the various measurements involved in power generation plants.
CO3: To provide knowledge about the different types s used for analysis.
CO4: To part knowledge about the different types of controls and in control loops.
Module 1: OVERVIEW OF POWER GENERATION (8 hours) Concepts of energy conversions and measurement requirements for power plants, Brief survey of methods of power generation – Hydro, thermal, nuclear, solar and wind power – Importance of instrumentation in power generation.
Module 2: MEASUREMENTS IN POWER PLANTS (8 hours) Electrical measurements – Current, voltage, power, frequency, power factor etc. – Non electrical parameters – Flow of feed water, fuel, air and steam with correction factor for temperature – Steam pressure and steam temperature – Drum level measurement – Radiation detector – Smoke density measurement – Dust monitor, Analyser type instruments.
Module 3: ANALYSERS IN POWER PLANTS (8 hours) Flue gas oxygen analyzer – Analysis of impurities in feed water and steam – Dissolved oxygen analyzer – Chromatography – pH meter – Fuel analyzer – Pollution monitoring instruments.
Module 4: CONTROL LOOPS IN BOILER (8 hours) Combustion control – Air/fuel ratio control – Furnace draft control – Drum level control – Main steam and reheat steam temperature control – Super heater control – Air temperature – Deaerator control – Distributed control system in power plants – Interlocks in boiler operation.
Module 5: TURBINE – MONITORING AND CONTROL (4 hours) Speed, vibration, shell temperature monitoring and control – Steam pressure control – Lubricant oil temperature control – Cooling system.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	2	2	3	-	-	1	-	-	1	-	-
CO 2	2	2	1	2	-	-	2	1	-	-	-	-
CO 3	1	2	1	1	3	-	2	-	1	-	-	-
CO 4	2	1	1	-	-	1	-	-	1	-	1	-

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	2	3	-
CO 2	2	3	-
CO 3	2	3	-
CO 4	2	3	-

Text Books:

1. Sam G. Dukelow, 'The Control of Boilers', Instrument Society of America,1991.
2. P.K. Nag, 'Power Plant Engineering', Tata McGraw Hill,2001.

Reference Books:

1. S.M. Elonka and A.L. Kohal, 'Standard Boiler Operations', Tata McGraw Hill, NewDelhi,1994.
2. R.K.Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, New Delhi,1995.
3. E.Al. Wakil, 'Power Plant Engineering', Tata McGraw Hill,1984.

Course Title: Industrial Safety and Management

Course Code: OE-EE702C	**Category**: Open Elective Courses
Course Title: Industrial Safety and Management	**Semester**: 7th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic of Industrial Safety, Maintenance.	

Course Outcomes:

CO1: Interpret the theoretical concepts and practices of industrial safety

CO2:Develop different types of safety procedures and formats and prepare reports.

CO3: Illustrate how the basic principles of management can be applied in safety.

CO4: Construct the basic outline of a safety programme.

Module 1: Industrial safety(12 hours)

Accident, causes, types, results and control, mechanical and electricalhazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 forhealth and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressurevessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Module 2: Fault tracing(8 hours)

Fault tracing-concept and importance, decision tree concept, need andapplications, sequence of fault finding activities, show as decision tree, draw decision tree forproblems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's likei. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi.Electrical motors, Types of faults in machine tools and their general causes.

Module 3: Safety Education and Training(10 hours)

Importance of training-identification of training needs-training methods, training evaluation methods, program, seminars, conferences, competitions, method of promoting safe practice, motivation, communication, role of government agencies and private consulting agencies in safety training, creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign, Domestic Safety and Training.

Module 4: Effective Safety Management System and Ethics(6 hours)

Purpose, Safety Culture, Safety functions, Elements of process safety management, Behavior Based Safety, Elements of Safety Management System, Concept of BBIP, OSHA guidelines, Voluntary Safety and Health Program management guidelines, 1989.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	3	2	2	1	-	1	-	3	2	1	2
CO 2	3	3	1	3	2	-	1	-	2	2	2	1
CO 3	2	3	2	2	2	-	-	3	2	2	2	2
CO 4	2	3	2	2	2	2	2	-	1	2	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	3	2
CO 2	2	2	2
CO 3	2	1	2
CO 4	2	2	1

Text Books:

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, Third edition 2008.
2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, Fifth Edition 2007

Reference Books:

1. Roland P. Blake, "Industrial Safety" Prentice Hall, Inc., New Jersey, Second Edition, 1997
2. "Industrial safety management", L M Deshmukh, TATA McGraw Hill, Forth edition, 2010.

Course Name: Principle of Management

Course Name: Principle of Management	**Category:** Humanities & Social Sciences
Course Code: HM-EE 701	**Semester:** 7th
L-T-P: 3-0-0	**Credit:** 3
Pre-Requisites: Basics of industrial aspects	
Course Outcomes (CO):	
CO1: Learn the basic concepts, principles and practices of management	
CO2: Explore the roles and skills required for managers	
CO3: Devise strategies for efficiently strategizing, coordinating, guiding, and overseeing diverse managerial functions. Apply management expertise to analyze and resolve organizational issues while formulating optimal managerial decisions.	
CO4: Grasp the intricate challenges entailed in managing human resources within organizations and synthesize this understanding to effectively address these challenges. Additionally, leverage new technological advancements in finance, marketing and operations to drive tangible and impactful results.	
Module 1: General Management (6 hours) Basic concepts of management: Definition - Essence, Functions, Roles, Level Functions of Management: Planning - Concept, Nature, Types, Management by objectives.	
Module 2: OB & HR (6 hours) Organization Structure: Concept, Structure, Centralization, Decentralization, Span of Management, Organizational Effectiveness. People Management: Overview, Recruitment & Selection, Training & Development, Stress Management, Communication, Motivation, Leadership, Team Effectiveness	
Module 3: Economics & Finance (6 hours) Economic: Factors affecting Production, Types of Markets, Financial Function & Goals Decision making: Concept, Nature, Process, Tools & techniques.	
Module 4: Marketing (6 hours) Customer Management: Market Planning & Research, Marketing Mix, Advertising & Brand Management.	

Module 5: Operations & Technology Management (6 hours) Operations & Technology Management: Role of Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.
Module 6: Entrepreneurship (6 hours) Introduction to Entrepreneurship: Starts ups, Prospects & Challenges, Sustaining business Management and Society: Concept, External Environment, CSR, Corporate Governance, Ethical Standards.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	-	2	-	1	2	2	2	1	-	2	2
CO 2	-	1	2	2	2	-	-	2	1	1	-	2
CO 3	1	2	-	3	-	1	2	-	-	-	1	1
CO 4	1	2	1	2	2	1	-	-	2	-	2	1

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	-	-	3
CO 2	1	-	-
CO 3	-	-	2
CO 4	-	-	3

Text Books:

1. Principles of Management- Competencies, Processes & Practices - Bhat, A & Kumar, A (OUP).
2. Essentials for Management - Koontz, H. Tata McGraw Hill (TMH).
3. Fundamentals of Management – Robbins, S., M. Coulter & M, Cenzo, D. Pearson.

Reference Books:

1. Principles of Management and Administration, Bose, D.C. Prentice Hall of India.
1. Principles of Management – Tripathi, P.C., Reddy, P.N. & Bajpai, A., McGraw Hill.

Course Title: Internship-I

Course Code: SE-EE781	**Category**: Project, Seminar, Industrial Visit (Sessional)
Course Title: Internship-I	**Semester**: 7th

L-T-P:0-0-0	**Credit: 3**
Pre-Requisites: Nil	
Course Outcomes:	
CO1: Know the importance of safety practices and comprehend the industrial operations during the training at the industry.	
CO2: Analyze the various operational procedures of an industry to identify imminent utilizing the safety parameters.	
CO3: Create a report reflecting all the findings during the tenures of the training problems.	
CO4: Understand and adhere to ethical principles and standards in the workplace.	

In this course, students should undergo in reputed Private / Public Sector / Government organization / companies as industrial training in the winter/summer vacation during 3rd year as per AICTE curriculum.

The training is graded based on:
Presentation: 25%
Student's reports: 40%
Viva voce: 25%
Duration of the training: 10%
Report must be submitted during presentation.

CO & PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	1	1	1	1	2	3	-	-	3	3	2	2
CO 2	2	2	2	2	2	3	2	2	3	3	3	2
CO 3	2	2	2	3	3	3	3	3	3	3	3	2
CO 4	1	1	1	1	2	3	-	-	3	3	2	2

CO & PSO Mapping:

	PSO1	**PSO2**	**PSO3**
CO 1	1	1	1
CO 2	2	-	2
CO 3	2	2	-
CO 4	1	1	1

Course Title: Project-I

Course Code: PR-EE782	**Category**:Project, Seminar, Industrial Visit(Sessional)
Course Title: Project-I	**Semester**: 7th
L-T-P:0-0-8	**Credit: 4**
Course Outcomes:	
CO1: Identify the area of interest and select the topic on which work can be done and study the available documents related to the topic.	
CO2: Interpret a model and study the output data under different experimental conditions.	
CO3: Apply mathematical principles to solve problems encountered during the project work	
CO4: Analyze the data collected during the project work to make intended decisions and improvement	

Students are expected to choose real world or relevant problems and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	2	3	3	3	3	2	2	2	3	2	2
CO 2	2	2	1	2	2	3	2	2	2	2	2	3
CO 3	2	3	3	3	3	3	2	1	2	2	2	3
CO 4	2	2	2	2	2	3	2	2	2	2	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	1	2
CO 3	1	2	3
CO 4	2	3	2

SEMESTER-VIII

Course Code: HM-EE801	**Category:** Humanities& Social Science Courses
Course Title: Organizational Behaviour	**Semester:** 8th
L-T-P: 2-0-0	**Credit:** 2
Pre-Requisites: Basic concept of management	
Course Outcomes (CO):	
CO1: Analyze and appreciate the role of individual factors upon decision making in organizations.	
CO2: Understand the effect of motivation in achieving organizational excellence.	
CO3: Appraise the guidelines for applying proper leadership styles on different contexts.	
CO4: Appraise the importance of various types of organization communication as a part of managerial skill development.	
Module1: Introduction (2 hours) Importance, Challenges for OB, Organizational Culture	
Module2: Personality and Attitudes (2 hours) Personality Determinants and Traits, Development of Personality, Types of Attitudes	
Module3: Perception (2 hours) Importance, Factors influencing Perception, Link between Perception and Decision Making.	
Module4: Motivation (4 hours) Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X &Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.	
Moudule5: Group Behaviour (4 hours) Characteristics of Group, Stages of Group Development, Group Decision Making.	
Module6: Communication (2 hours) Communication Process, Direction of Communication, Barriers to Effective Communication.	
Module7: Leadership (4 hours) Importance, Theories of Leadership Styles.	
Module8: Conflict Management (4 hours) Functional and Dysfunctional Conflict, Conflict Process, Negotiation Process	

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	2	3	3	3	3	2	2	2	3	2	2
CO 2	2	2	1	2	2	3	2	2	2	2	2	3
CO 3	2	3	3	3	3	3	2	1	2	2	2	3
CO 4	2	2	2	2	2	3	2	2	2	2	2	3

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	1	1	2
CO 3	1	2	3
CO 4	2	3	2

Text Books:

1.Organizational Behaviour – Robbins, S.P., Judge, T.A. & Vohra, N., Pearson.
2.A textbook of Organizational Behaviour – Prasad, L.M. Sultan Chand & Sons.
3. Management and Organizational Behaviour – Mullins, L.J. & Christy, G., Pearson.

Reference Books:

1.Organizational Behaviour – McShane, S.L., Glinow, M.A.V. & Rai, H., McGraw Hill.
2. Organizational Behavior – Luthans, F. McGraw Hill.

Course Title: Internship-II

Course Code: SE-EE881	**Category**: Project, Seminar, Industrial Visit (Sessional)
Course Title: Internship-II	**Semester**: 8th
L-T-P:0-0-8	**Credit: 4**
Course Outcomes (CO):	
CO1: Apply the theoretical concepts they've learned in the classroom to real-world situations.	
CO2: Develop essential soft skills in Electrical Engineering domain as well as in software domain such as Programming Language, communication, teamwork, problem-solving, etc.	
CO3: Build-up students' confidence and independence to take initiative, meet deadlines, and handle challenges.	
CO4: Create a report reflecting all the findings during the tenures of the training problems.	

In this course, students should undergo in reputed Private / Public Sector / Government organization / companies as industrial training in the winter/summer vacation during 3rd year and 4th year as per AICTE curriculum. Students are expected to write internship report and give the presentation during one assigned session.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	1	1	2	3	-	-	3	3	2	2
CO 2	2	2	2	2	2	3	2	2	3	3	3	2
CO 3	2	2	2	3	3	3	3	3	3	3	3	2
CO 4	1	1	1	1	2	3	-	-	3	3	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	3
CO 2	2	2	2
CO 3	2	-	1
CO 4	3	1	1

Course Code: Project-II

Course Code: PR-EE882	**Category**: Project, Seminar, Industrial Visit(Sessional)
Course Title: Project-II	**Semester**: 8th
L-T-P:0-0-12	**Credit: 6**
Course Outcomes (CO):	
CO1: Determine the appropriate methodologies for completing the project tasks effectively.	
CO2: Compareand contrast different approaches to achieve project objective.	
CO3: Assess personal contributions and recommend areas of improvement.	
CO4: Generate innovative solutions to project related problems.	

Students are expected to continue their Project-I topic through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel can decide the suitability and worthiness of the project.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	3	2	0	3	2	2	3	2	2	3

CO 2	2	2	3	3	3	3	2	2	3	3	2	3
CO 3	2	3	3	2	2	3	2	2	2	3	2	3
CO 4	2	2	2	2	2	3	2	1	2	2	2	2

CO & PSO Mapping:

	PSO1	**PSO2**	**PSO3**
CO 1	3	2	1
CO 2	1	2	2
CO 3	2	2	3
CO 4	2	3	2

Course Title: Comprehensive Viva Voce

Course Code: VI-EE883	**Category**: Viva Voce (Sessional)
Course Title: Comprehensive Viva Voce	**Semester**: 8th
L-T-P: Nil	**Credit: 1**
Course Outcomes (CO):	
CO1: Demonstrate the knowledge acquired based on curricular and cocurricular activities to solve electrical engineering related problems.	
CO2: Exhibit discussion and listening skills.	
CO3: Demonstrate argumentative skills and critical thinking.	
CO4: Work effectively as an individual and communicate effectively during oral presentations.	

The objective of this Comprehensive Viva Voce is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

CO & PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	2	-	2	3	2	-	2	3	2	1
CO 2	3	2	-	-	-	2	-	-	2	3	1	1
CO 3	3	2	-	2	2	2	-	-	2	3	1	2
CO 4	3	2	-	-	-	2	-	2	3	3	2	2

CO & PSO Mapping:

	PSO1	PSO2	PSO3
CO 1	3	2	1
CO 2	2	2	3
CO 3	2	2	2
CO 4	2	1	2

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List of MOOCs for UG Honours degree (AICTE Programmes)

for ELECTRICAL ENGINEERING

Sl. No	Course name	Duration (weeks)	Credits	Name of the MOOC websites	Link
1	Algorithms for Battery Management Systems	21	4	Coursera	https://www.coursera.org/specializations/algorithms-for-battery-management-systems
2	Advanced Data Science with IBM Specialization	20	4	Coursera	https://www.coursera.org/specializations/advanced-data-science-ibm
3	Machine Learning with Python: from linear models to deep learning	15	3	Edx	https://www.edx.org/course/machine-learning-with-python-from-linear-models-to
4	Electronic Systems for Cancer Diagnosis	12	3	NPTEL	https://nptel.ac.in/courses/108/108/108108124/
5	Artificial Intelligence: Knowledge Representation and Reasoning	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs26
6	An Introduction to AI	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs42

7	Data Analytics with Python	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs45
8	Introduction to Internet of Things	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs63
9	Introduction to Machine Learning (IITM)	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs70
10	Deep Learning	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs76
11	Artificial Intelligence (AI)	12	3	Edx	https://www.edx.org/course/artificial-intelligence-ai
12	IBM DATA SCIENCE	12	3	Coursera	https://www.coursera.org/professional-certificates/ibm-data-science
13	Data Analysis and Presentation Skills: the PwC Approach Specialization	12	3	Coursera	https://www.coursera.org/specializations/pwc-analytics
14	Data Science: Statistics and Machine Learning Specialization	12	3	Coursera	https://www.coursera.org/specializations/data-science-statistics-machine-learning

List of MOOCs for UG Honours degree (AICTE Programmes)

for ELECTRICAL ENGINEERING

Sl. No	**Course name**	**Duration (weeks)**	**Credits**	**Name of the Mooc websites**	**Link**
15	Machine Learning, ML	12	3	Coursera	https://www.coursera.org/learn/machine-learning

16	Introduction to Machine Learning	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs85
17	Mathematical Methods and Techniques in Signal Processing	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee04
18	Nonlinear System Analysis	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee06
19	Biomedical Signal Processing	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee17/
20	Power Management Integrated Circuits	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee25
21	High Power Multilevel Converters - Analysis, Design and Operational Issues	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee29
22	Principles of Digital Communication	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee30/
23	Multirate DSP	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee36
24	Statistical Signal Processing	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee44
25	Fuzzy Sets, Logic and Systems & Applications	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee49
26	Fabrication Techniques for MEMs- based sensors: clinical Perspective	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee60

27	Optical Engineering	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee81
28	Introduction to Cyber Security	12	3	Swayam	https://onlinecourses.swayam2.ac.in/nou21_cs01

List of MOOCs for UG Honours degree (AICTE Programmes)

for ELECTRICAL ENGINEERING

Sl. No	Course name	Duration (weeks)	Credits	Name of the Mooc websites	Link
29	Fabrication Techniques for MEMs-based sensors: clinical Perspective	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc19_ee40
30	Artificial Intelligence Search Methods For Problem Solving	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc20_cs81
31	Introduction to Machine Learning (IITM)	12	3	Swayam	https://onlinecourses.nptel.ac.in/noc19_cs53
32	Introduction to Cyber Security	12	3	Swayam	https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
33	Artificial Intelligence (AI)	12	3	Edx	https://www.edx.org/course/artificial-intelligence-ai

34	Machine Learning Fundamentals	10	2	Edx	https://www.edx.org/course/machine-learning-fundamentals-2
35	Advanced Power Electronics and Control	8	2	NPTEL	https://nptel.ac.in/courses/108/107/108107128/
36	VLSI Signal Processing	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc20_ee44/
37	Embedded System Design with ARM	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs09
38	Machine Learning	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs51
39	Data Science for Engineers	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs69
40	Data Science for Engineers	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs69
41	CMOS Digital VLSI Design	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee09
42	Microwave Integrated Circuits	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee34

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for ELECTRICAL ENGINEERING

Sl. No	**Course name**	**Duration (weeks)**	**Credits**	**Name of the Mooc websites**	**Link**

43	Electronics Equipment Integration and Prototype Building	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee45
44	Discrete Time Signal Processing	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee54
45	Power Quality Improvement Technique	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc21_ee56
46	Data Science for Engineers	8	2	Swayam	https://onlinecourses.nptel.ac.in/noc19_cs60
47	Deep learning and neural network for financial engineering	7	1	Edx	https://www.edx.org/course/deep-learning-and-neural-networks-for-financial-engineering
48	Electric Vehicles and Mobility	6	1	Coursera	https://www.coursera.org/learn/electric-vehicles-mobility
49	Equivalent Circuit Cell Model Simulation	6	1	Coursera	https://www.coursera.org/learn/equivalent-circuit-cell-model-simulation
50	Battery State-of-Health (SOH) Estimation	6	1	Coursera	https://www.coursera.org/learn/battery-state-of-health

51	Industry 4.0: How to Revolutionize your Business	6	1	Edx	https://www.edx.org/course/industry-40-how-to-revolutionize-your-business
52	Drones and Autonomous Systems I: Fundamentals	6	1	Edx	https://www.edx.org/course/drones-and-autonomous-systems-i-fundamentals
53	Principles of Machine Learning: Python Edition	6	1	Edx	https://learning.edx.org/course/course-v1:Microsoft+DAT275x+2T2018/home
54	Introduction to the Internet of Things (IoT)	6	1	Edx	https://www.edx.org/course/introduction-to-the-internet-of-things-iot
55	Machine Learning with Python	6	1	Coursera	https://www.coursera.org/learn/machine-learning-with-python
56	Electric Utilities Fundamentals and Future	5	1	Coursera	https://www.coursera.org/learn/electric-utilities
57	Solar Energy Codes, Permitting and Zoning	5	1	Coursera	https://www.coursera.org/learn/solar-energy-codes-permitting-zoning

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for ELECTRICAL ENGINEERING

Sl. No	Course name	Duration (weeks)	Credits	Name of the MOOCSwebsites	Link
58	Motors and Motor Control Circuits	5	1	Coursera	https://www.coursera.org/learn/motors-circuits-design
59	Introduction to solar cells	5	1	Coursera	https://www.coursera.org/learn/solar-cells
60	Solar Energy and Electrical System Design	5	1	Coursera	https://www.coursera.org/learn/solar-energy-and-electrical-system-design
61	Solar Energy System Design	5	1	Coursera	https://www.coursera.org/learn/solar-energy-system-design
62	Solar Energy Basics	5	1	Coursera	https://www.coursera.org/learn/solar-energy-basics
63	Python for Data Science and AI	5	1	Coursera	https://www.coursera.org/learn/python-for-applied-data-science-ai
64	Data Processing Using Python	5	1	Coursera	https://www.coursera.org/learn/python-data-processing
65	Solar Energy Basics	5	1	Coursera	https://www.coursera.org/learn/solar-energy-basics
66	Energy Harvesting	4	1	Coursera	https://www.coursera.org/learn/energy-harvesting
67	Medical Image Analysis	4	1	NPTEL	https://nptel.ac.in/courses/108/105/108105091/

68	Python and Statistics for Financial Analysis	4	1	Coursera	https://www.coursera.org/learn/python-statistics-financial-analysis
69	Interfacing with the Arduino	4	1	Coursera	https://www.coursera.org/learn/interface-with-arduino
70	Excel Power Tools for Data Analysis	4	1	Coursera	https://www.coursera.org/learn/excel-power-tools
71	Safety in the Utility Industry	4	1	Coursera	https://www.coursera.org/learn/safety-utility-industry
72	A brief Introduction to Micro-sensors	4	1	NPTEL	https://nptel.ac.in/courses/108/106/108106165/

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for ELECTRICAL ENGINEERING

Sl. No	Course name	Duration (weeks)	Credits	Name of the Mooc websites	Link
73	Design and Simulation of Power Conversion using Open Source Tools	4	1	NPTEL	https://nptel.ac.in/courses/108/108/108108166/
74	Recent Advances in Transmission Insulator	4	1	NPTEL	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee43/
75	Electric Vehicles Part 1	4	1	NPTEL	https://www.nptel.ac.in/courses/108/102/108102121/
76	Electric Cars: Introduction	4	1	Edx	https://www.edx.org/course/electric-cars-introduction

77	Real Time Operating System	4	1	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs10
78	Applied Machine Learning in Python	4	1	Coursera	https://www.coursera.org/learn/python-machine-learning
79	Python for Data Science	4	1	Swayam	https://onlinecourses.nptel.ac.in/noc21_cs78
80	Introduction to computer vision with Watson and opencv	6	1	Coursera	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
81	Introduction to the Internet of Things (loT) and embedded system	4	1	Coursera	https://www.coursera.org/learn/iot
82	loT Networking and Fog Layer Devices	4	1	Edx	https://www.edx.org/course/iot-networking-and-fog-layer-devices
83	Python for Data Science	4	1	Swayam	https://onlinecourses.nptel.ac.in/noc19_cs59

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