Haldia Institute of Technology
West Bengal

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

Curriculum Structure for B. Tech. courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Haldia Institute of Technology, West Bengal
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Departmental of Electrical Engineering

VISION

To be a forerunner 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 resource 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 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):

PO 1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/ development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigation of Complex Problem: 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.

PO 5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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.

PO 12: Life-long 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 2020-2021)

SEMESTER - I

Theory

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-M 101	Mathematics –I [Group-A and B]	3	1	0	4	4
2	BS-PH 101/ BS-CH101	Physics-I [Group-A] / Chemistry-I [Group-B]	3	1	0	4	4
3	ES-EE 101/ ES-CS101	Basic Electrical and Electronics Engineering [Group-A]/ Programming for problem solving [Group-B]	3	1	0	4	4
4	HM-HU101	English Language and Technical Communication [Group-B]	2	0	0	2	2
		Total Theory					Group-A: **12.0** Group-B: **14.0**

Practical/ Sessional

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-PH 191/ BS-CH 191	Physics-I Lab [Group-A] / Chemistry-I Lab [Group-B]	0	0	3	3	1.5
2	ES-EE 191/ ES-CS191	Basic Electrical and Electronics Engineering lab[Group-A] / Programming Lab [Group-B]	0	0	3	3	1.5
3	ES-ME 191/ ES-ME 192	Workshop Practice [Group-A] / Engineering Drawing [Group-B]	1	0	3	4	2.5
4	HM-HU191	Language Practice Lab [Group-B]	0	0	2	2	1
		Total Practical / Sessional					Group-A: **5.5** Group-B: **6.5**
Total Semester							Group-A: **17.5** Group-B: **20.5**

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

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SEMESTER – II

Theory

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-M 201	Mathematics-II [Group A and B]	3	1		4	4
2	BS-CH 201 / BS-PH 201	Chemistry-I [Group-A] / Physics-I [Group-B]	3	1		4	4
3	ES-CS 201 / ES-CS 201	Programming for problem solving [Group-A] / Basic Electrical and Electronics Engineering [Group-B]	3	1	0	4	4
4	HM-HU 201	English Language and Technical Communication [Group-A]	2	0	0	2	2
		Total Theory				14	Group-A: **14.0** Group-B: **12.0**

Practical/ Sessional

Sl. No.	Subject Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	BS-CH 291 / BS-PH 291	Chemistry-I Lab [Group-A] / Physics-I Lab [Group-B]	0	0	3	3	1.5
2	ES-CS 291 / ES-EE 291	Programming Lab [Group-A] / Basic Electrical and Electronics Engineering lab[Group-B]	0	0	3	3	1.5
3	ES-ME 292 / ES-ME 291	Engineering Drawing [Group-A] / Workshop Practice [Group-B]	1	0	3	4	2.5
4	HM-HU 291	Language Practice Lab [Group-A]	0	0	2	2	1
		Total Practical / Sessional					Group-A: **6.5** Group-B: **5.5**
Total Semester							Group-A: **20.5** Group-B: **17.5**

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SEMESTER – III

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 301	Electrical Network Analysis	3	1	0	4	4
2	PC-EE 302	Analog Electronics Circuit	3	0	0	3	3
3	PC-EE 303	Electric field theory	3	0	0	3	3
4	BS-EE 302	Biology for Engineers	3	0	0	3	3
5	BS-M 301	Mathematics -III	3	0	0	3	3
6	ES-ME 301	Engineering Mechanics	3	0	0	3	3
7	MC-EE 301	Indian Constitution	3	0	0	3	
		Total Theory				**22**	**19**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 391	Electric Network Analysis Lab	0	0	2	2	1
2	PC-EE 392	Analog Electronics Lab	0	0	2	2	1
3	PC-CS 391	Numerical Methods Lab	0	0	2	2	1
		Total Practical / Sessional				**6**	**3**
Total Semester						**28**	**22**

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SEMESTER – IV

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 401	Electric machine-I	3	1	0	4	4
2	PC-EE 402	Digital Electronics	3	0	0	3	3
3	PC-EE 403	Electrical and Electronics Measurement	3	0	0	3	3
4	ES-ME 401	Thermal Power Engineering	3	0	0	3	3
5	HM-EE 401	Values and Ethics in Profession	3	0	0	3	3
6	MC-EE 401	Environmental Science	3	0	0	3	0
		Total Theory				**19**	**16**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 491	Electric machine-I Lab	0	0	2	2	1
2	PC-EE 492	Digital Electronics Lab	0	0	2	2	1
3	PC-EE 493	Electrical and Electronics Measurement Lab	0	0	2	2	1
4	ES-ME 481	Thermal Power Engineering Lab	0	0	2	2	1
		Total Practical / Sessional				**8**	**4**
Total Semester						**27**	**20**

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SEMESTER –V

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 501	Electric machine-II	3	0	0	3	3
2	PC-EE 502	Power System-I	3	0	0	3	3
3	PC-EE 503	Control system	3	0	0	3	3
4	OE-EE 501	Open Elective - I	3	0	0	3	3
5	PE-EE 501	Professional Elective - I	3	0	0	3	3
6	HM-EE 501	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-EE 591	Electric machine-II Lab	0	0	2	2	1
2	PC-EE 592	Power System-I Lab	0	0	2	2	1
3	PC-EE 593	Control system Lab	0	0	2	2	1
4	OE-EE 581	Open Elective - I Lab	0	0	2	2	1
5	SE-EE 581	Term Paper and Seminar	0	0	2	2	1
		Total Practical / Sessional				**10**	**5**
Total Semester						**28**	**23**

Professional Elective - I		**Open Elective - I**	
PE-EE 501A	Digital Signal Processing	OE-EE 501A / OE-EE 591A	Data Structure and Algorithm/ Data Structure and Algorithm Lab
PE-EE 501B	Computational Electromagnetic		

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SEMESTER –VI

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 601	Power System - II	3	0	0	3	3
2	PC-EE 602	Power Electronics	3	0	0	3	3
3	PC-EE 603	Microprocessor & microcontroller	3	0	0	3	3
4	PE-EE 601	Professional Elective - II	3	0	0	3	3
5	OE-EE 601	Open Elective - II	3	0	0	3	3
6	HM-EE 601	Principal of Management	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-EE 691	Power System - II Lab	0	0	2	2	1
2	PC-EE 692	Power Electronics Lab	0	0	2	2	1
3	PC-EE 693	Micro processor& micro controller Lab	0	0	2	2	1
4	OE-EE691	Open Elective - II Lab	0	0	2	2	1
		Total Practical / Sessional				**8**	**4**
Total Semester						**26**	**22**

Professional Elective - II		**Open Elective - II**	
PE-EE 601A	Digital Control System	OE-EE601A/ OE-EE691A	Data Base Management System/ Data Base Management System Lab
PE-EE 601B	Advanced Control System	OE-EE 601B/ OE-EE 691B	Object Oriented Programming / Object Oriented Programming Lab
		OE-EE601C/ OE-EE691C	Data Science with Python/ Data Science with Python Lab

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SEMESTER –VII

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PE-EE 701	Professional Elective - III	3	0	0	3	3
2	PE-EE 702	Professional Elective - IV	3	0	0	3	3
3	OE-EE 701	Open Elective - III	3	0	0	3	3
4	OE-EE 702	Open Elective - IV	3	0	0	3	3
		Total Theory				**12**	**12**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PE-EE 791A	Professional Elective - III lab	0	0	2	2	1
2	SE-EE 781	Seminar on Industrial Training	0	0	0	0	2
3	PR-EE 782	Project - I	0	0	6	6	3
		Total Practical / Sessional				**10**	**06**
Total Semester						**22**	**18**

Professional Elective - III		**Open Elective - III**	
PE-EE701A/ PE-791A	Electrical Drives / Electrical Drives Lab	OE-EE701A	Computer Networking
		OE-EE 701B	Artificial Intelligence and Machine Learning
Professional Elective - IV		**Open Elective - IV**	
PE-EE702A	High Voltage Engineering	OE-EE 702A	Power Plant Engineering
PE-EE702B	Utilization of Electric Power	OE-EE 702 B	Renewable Energy
PE-EE702C	Advanced Power Systems	OE-EE 702C	Electric Vehicle Technology
PE-EE702D	Embedded Systems	OE-EE 702D	Power Plant Instrumentation and Control

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SEMESTER –VIII

Theory

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	HM-EE 801	Organizational Behaviour	2	0	0	2	2
2	PE-EE 801	Professional Elective - V	3	0	0	3	3
		Total Theory				**5**	**5**

Practical/ Sessional

Sl. No.	Code	Paper	Contact period per week			Total Contact Hrs	Credits
			L	T	P		
1	PR-EE881	Project -II	0	0	10	10	5
2	PE-EE881	Electrical System design	0	0	4	4	2
3	SE-EE882	Comprehensive Viva Voce					1
4	SE-EE883	Seminar on Internship					4
		Total Practical / Sessional				**14**	**12**
Total Semester						**19**	**17**

Professional Elective -V	
PE-EE801A	HVDC Transmission
PE-EE801B	Energy management & audit
PE-EE801C	Illumination Technology
PE-EE801D	Sensors and Transducers

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2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: PC-EE301	**Category**: Professional Core Courses
Course Title: Electrical Network Analysis	**Semester**: Third
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.	
Module 2: Magnetically Coupled Circuits (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: Laplace Transform (10 hours) Impulse, Step & Sinusoidal response of RL,RC, and RLC circuits. Transient analysis of different electrical circuits with and without initial conditions. Concept of Convolution theorem and its application. Solution of Problems with DC & AC sources.	
Module 4: Fourier method of waveform analysis (6 hours) Fourier series and Fourier Transform (in continuous domain only). Application in circuit analysis,Solution of Problems	
Module 5:Network Theorem (8 hours) Formulation of network equations, Source transformation, Loop variable analysis and Node variable analysis (including Supermesh 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. Solution of Problems with independent and dependent DC and AC sources.	
Module 6: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 7: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 amplifier. Solution of Problems
Module 8: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.

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	-	-	-	2	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 Hillpublisher

2. Network Analysis &Synthesis, Ravish R. Singh, McGraw Hill Education (India) Pvt.Ltd.

3. Networks and Systems, D. Roy Chowdhury, New Age InternationalPublishers

5. 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, PearsonEducation

4. Engineering Circuit Analysis, W.H. Hyat, J.E. Kemmerly& S.M. Durbin, The McGraw Hill Company

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2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

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Course Code: PC-EE 302	**Category**: Professional Core Courses
Course Title: Analog Electronics Circuit	**Semester**: Third
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: Diodes and Application(4 hours) The PN junction, Biasing the semiconductor diode, Terminal characteristics of junction diodes, simple applications of diodes: rectifier circuits, clipping and clamping circuits. Introduction to Zener diode.
Module 2:BJT(6 hours) Device structure and physical operation, terminal characteristics, Bipolar Transistor amplifier circuits, Bipolar Transistor as switch, low and high frequency response different bipolar transistors.
Module 3: Multi-staging and Power amplifiers(8 hours) Capacitively coupled amplifiers, Transformer coupled amplifiers, Direct coupled amplifiers, class A power Amplifiers, class B power Amplifiers, class C and D power Amplifiers.
Module 4: Field Effect Transistors(10 hours) Structure of Field Effect Transistors, JFET characteristics and biasing, MOSFET characteristics and biasing, small and high frequency equivalent circuits and parameters, linear amplifiers.
Module 5: 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 6: Application of Op-amp and Oscillators(10 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, PHIPublication

2. Analog and Digital Electronics, Sanjay Agrawal, Sonveer Singh, Wiley Publication Company

Reference Books:

3. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press,1989.

4. P. R. Gray, R. G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, JohnWiley& Sons, 2001.

5. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press,1998.

6. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education,1988.

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Course Code: PC-EE 303	**Category**: Professional Core Courses
Course Title: Electric Field Theory	**Semester**: Third
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 (6 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 (6 Hours) 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 (4 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 (4 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 byW.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.

Haldia Institute of Technology, West Bengal

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

2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: BS-EE302	**Category**: Basic Science Courses
Course Title: Biology for Engineers	**Semester**: Third
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Basic Biology	
Course Outcomes:	
CO 1: Understand and explain the biological concepts from an engineering perspective.	
CO2: Understand and explain the concepts of hierarchy of life forms at phenomenological level, biological sensing and its challenges.	
CO3: Understand and explain the concept of genetics as well as how genetic material passes from parent to offspring.	
CO4: Understand, assess and explain the different biomolecules as building blocks of life, macromolecular analysis, information transfer and metabolism as well as the basic concept of microbial system.	
Module 1: Introduction (2 hours) Purpose:To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead tomajor discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry	

Module 2: Classification (3 Hours)

To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life formsat phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multi cellular (b)ultra structure prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs,lithotropes (d) Ammonia excretion – aminotelic, uricotelic, ureotelic (e) Habitat- aquatic or terrestrial (e) Moleculartaxonomy- three major kingdoms of life. A given organism cancome under different category based on classification. Modelorganisms for the study of biology come from different groups.E. coli, S.cerevisiae, D. melanogaster, C. elegans,A. thaliana, M. musculus.

Module 3: Biomolecules (3 Hours)

To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine. Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA.Two carbon units and lipids.

Module 4: Macromolecular Analysis(5 Hours)

To analyze biological processes at the reductionistic level. Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 5: Metabolism(4Hours)

Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 +H2O (Glycolysis and Krebs cycle) and synthesis of glucose fromCO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.

Module6: Microbiology (3Hours)

Purpose: Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

Module7: Immunology(5Hours)

Purpose: How does the immune system work? What are the molecular and cellular components and pathways that protect an organism from infectious agents or cancer? This comprehensive course answers these questions as it explores the cells and molecules of the immune system. Immunology- Self vs Non-self, pathogens, human immune system, antigen-antibody reactions.

Module8: Information Transfer(4Hours)

Purpose: The molecular basis of coding and decoding genetic information is universal. Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene interms of complementation and recombination.

Module9: Cancer Biology (5Hours)

Purpose:A basic understanding of cancer biology and treatment. The course is not designed for patients seeking treatment guidance–but it can help to understand how cancer develops and provides a framework for understanding cancer diagnosis and treatment. Identification of the major types of cancer worldwide. Description of how genes contribute to the risk and growth of cancer. List and description of the ten cellular hallmarks of cancer. Definition of metastasis, and identification of the

major steps in the metastatic process. Description of the role of imaging in the screening, diagnosis, staging, and treatments of cancer. Explanation of how cancer is treated.
Module10:Techniques in Biophysics(3Hours) Purpose: Biophysics is an interdisciplinary science that applies approaches and methods traditionally used in physics to study biological phenomena. The techniques including microscopy, spectroscopy, electrophysiology, single-molecule methods and molecular modeling.
Module 11: Stem Cell (2Hours) Purpose: Stem cells and derived products offer great promise for new medical treatments. Learn about stem cell types, current and possible uses, ethical issues.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Text/References:

1. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, “Biology: A global approach, Pearson Education Ltd, 2014.
2. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, “Outlines of Biochemistry, John Wiley and Sons, 2009.
3. D. L. Nelson and M. M. Cox, “Principles of Biochemistry, W.H. Freeman and Company, 2012.
4. G. S. Stent and R. Calendar, “Molecular Genetics, Freeman and company, 1978.
5. L. M. Prescott, J. P. Harley and C. A. Klein, “Microbiology, McGraw Hill Higher Education, 2005.

Haldia Institute of Technology, West Bengal

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2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: **BS-M301**	**Category**: Basic Science Courses
Course Title: **Mathematics-III**	**Semester**: Third
L-T-P : 3-0-0	**Credit: 3**
Prerequisites: Basics of Mathematics	

Course Outcomes:

CO1: Recall the earlier mathematical thoughts

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 [6Hours]

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[4Hours]

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 [4Hours]

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 [4Hours]

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 [10Hours] 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 [8Hours] 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

References:

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

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2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: ES-ME 301	**Category**: Engineering Science Courses
Course Title: Engineering Mechanics	**Semester**: Third
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Mathematics , Physics	

Course Outcomes:

CO 1: To understand the basic mathematical tools to deal with the physical bodies.

CO2: To learn different mathematical techniques to analyze physical bodies.

CO3: To learn analysis techniques of rigid bodies.

CO4: To solve problem of general motion.

Module 1: Introduction to vectors and tensors and co-ordinate(5 hours)

Introduction to vectors and tensors and coordinate systems; Vector and tensor algebra; Indicial notation; Symmetric and anti-symmetric tensors; Eigen values and Principal axes.

Module 2: Three-dimensional Rotation (4 Hours)

Three-dimensional rotation: Euler's theorem, Axis-angle formulation and Euler angles; Coordinate transformation of vectors and tensors

Module 3: Conductors, Dielectrics and Capacitance (6 Hours)

Kinematics of Rigid Body Kinematics of rigid bodies: Dentition and motion of a rigid body; Rigid bodies as coordinate systems; Angular velocity of a rigid body, and its rate of change; Distinction between two and three dimensional rotational motion; Integration of angular velocity to find orientation; Motion relative to a rotating rigid body: Five term acceleration formula.

Module 4: Kinetics of Rigid Bodies(5 Hours)

Kinetics of rigid bodies: Angular momentum about a point; Inertia tensor: Dentition and computation, Principal moment sand axes of inertia, Parallel and perpendicular axes theorems; Mass moment of inertia of symmetrical bodies, cylinder, sphere, cone etc., Area moment of inertia and Polar moment of inertia, Forces and moments; Newton-Euler's laws of rigid body motion.

Module 5:Free Body Free body diagrams(1Hours)

Examples on modelling of typical supports and joints and discussion on the kinematic and kinetic constraints that they impose.

Module 6: General Motion (8Hours)

Examples and problems. General planar motions. General 3-D motions. Free precession, Gyroscopes, Rolling coin.

Module 7: Bending Moment(2Hours)

Transverse loading on beams, shear force and bending moment in beams, analysis of cantilevers, simply supported beams and overhanging beams, relationships between

loading and shear force and bending moment, shear force and bending moment diagrams.
Module 8: Torsional Motion(3Hours) Torsion of circular shafts, derivation of torsion equation, stress and deformation in circular and hollow shafts.
Module 8: Friction(3Hours) Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Text books:

1. J. L. Meriam and L. G. Kraige, “Engineering Mechanics: Dynamics”, Wiley,2011.
2. M. F. Beatty, “Principles of Engineering Mechanics”, Springer Science &Business Media, 1986.
3. Manoj K. Harbola, “ Engineering Mechanics”, Cengage Learning India Pvt. Ltd, 2018
4. D.S. Bedi& M.P. Poonia, “Engineering Mechanics”, Khanna Publishing House, 2019
5. R.S. Khurmi, “Engineering Mechanics”, S.Chand Publications
6. R.K. Bansal, “Engineering Mechanics”, Laxmi Publications

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2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: MC-EE 301	**Category**: Mandatory Courses
Course Title: Indian Constitution	**Semester**: Third
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 (5 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: Organisation, 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 of PIL, scope of PIL, principle of PIL, guidelines for admitting PIL.

Module 4: Local Administration (10 Hours)

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation,

Pachayati raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role

Block level: Organizational Hierarchy (Different departments)

Village level: Role of Elected and Appointed officials, Importance of grass 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, MC Graw Hill education, 5th Edition.

Reference books

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

Course Code: PC-EE391	**Category**: Professional Core Courses
Course Title: Electrical Network Analysis Laboratory	**Semester**: Third
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.

Choose 10 experiments from the following:

1.Introduction to MATLAB: Basic matrix operation, file operations, plotting, MATLAB program Development in 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

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(Applicable from the academic session 2020-2021)

Course Code: PC-EE 392	**Category**: Professional Core Courses
Course Title: Analog Electronics Lab	**Semester**: Third
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.	

Choose 10 experiments from the following:

1. MeasureandplottheforwardandreverseIVcharacteristicsofasilicondiodeand 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 dc point.
4. To demonstrate the dc operating point for transistor fix 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 study its gain and bandwidth.
10. Development of diode clipping and clamping circuits and analyze their outputs with different analog inputs.
11. Design opamp based differentiator and integrator and observe its response with different analog inputs.
12. Develop RC phase shift oscillator for 1kHz 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:

5.

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

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(Applicable from the academic session 2020-2021)

Course Code: **ES-CS 391**	**Category**: Engineering Science Courses
Course Title: **Numerical Methods Laboratory**	**Semester**: Third
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.

Laboratory Experiments:

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	-

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2nd Year Curriculum Structure for B. Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 401	**Category**: Professional Core
Course Title: Electric Machine-I	**Semester**: 4th
L-T-P:3-1-0	**Credit: 3+1**
Pre Requisites: Higher Secondary Level Physics and Mathematics	

Course Outcomes:

CO1: Recall the concepts of 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, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation, Derivation of back EMF equation, armature MMFwave, derivation of torque equation, armature reaction, airgap 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:Transformers (10 hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses 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	-	-	-
CO 2	3	2	2	3	2	2	2	1	-	1	2	1
CO 3	3	2	3	3	3	2	2	-	1	2	2	2
CO 4	3	3	2	2	2	2	3	1	2	3	2	2

CO & PSO Mapping:

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

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 Code: PC-EE 402	**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 (10 hours)

DATA AND NUMBER SYSTEM

Binary, Octal and Hexadecimal representation and their conversion, BCD, ASCII, EBDIC, 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 sub-tractor circuit, Circuit of Encoder, Decoder, Comparator, Multiplexer, De-Multiplexer, Parity Checker & Generator, Parity Encoder. Static and dynamic hazards for combinational logic.

Module 3: SEQUENTIAL CIRCUITS(9 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 (5hours)

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: (6 hours)
MEMORY SYSTEMS - RAM, ROM, EPROM, EEROM, LOGIC FAMILIES

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. Fundamental of Digital Circuits, A. Anand Kumar, PHI.
2. Modern Digital Electronics, 2nd Edition, R.P. Jain. Tata Mc Graw Hill Company Limited.
3. Digital Logic Design, Morries Mano,PHI.
4. Digital Principles & Application, 5th Edition, Leach & Malvino, Mc Graw Hill Company.

Haldia Institute of Technology, West Bengal

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

2nd Year Curriculum Structure for B. Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 403	**Category**: Professional Core Courses
Course Title: Electrical and Electronics Measurement	**Semester**: 4th
L-T-P : 3-0-0	**Credit: 3**
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: Analyze different characteristics and performances of measuring instruments.

Module 1: Introduction of Measurement (3 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 (5 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(4 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(5 Hours)

Power: Construction, Theory and principle of operation of electro dynamometer, electrostatic Wattmeter, Measurement of 1φ and 3 φ power by Wattmeter.

Energy: Construction, Theory and principle of operation of 1φ and 3φ Induction watt-hour meter, Errors and compensation.

Theory and operation of frequency, power-factor meters, calibration of Watt meters 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. Sampling and storage oscilloscope, Double beam CRO.

Module 6:Measurement of Resistance (8 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. AC potentiometers: Drysdale , Gall – Tinsley.
AC Bridge: Measurement of Inductance, Capacitance and frequency by AC bridges.

Module 7: Electronic Instruments for measurement of basic parameters: (3 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 (4 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, 2ndEdition.
2. Electronic Instrumentation &Measurements, David A. Bell, 3rd Edition, Oxford University press.
3. Instrument transducers, H.K.P. Neubert, Oxford University press.

Haldia Institute of Technology, West Bengal

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2nd Year Curriculum Structure for B. Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

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: High school 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.

Haldia Institute of Technology, West Bengal

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2nd Year Curriculum Structure for B. Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: HM-EE 401	**Category**: Humanities
Course Title: Values & Ethics in Profession	**Semester**: 4th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Science, Technology and Engineering as knowledge and as Social and Professional Activities	

Course Objectives:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty.
- To appreciate the rights of others.
- To create awareness on assessment of safety and risk.

Course Outcomes:

CO 1: Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field

CO 2: Identify the multiple ethical interests at stake in a real-world situation or practice

CO 3: Articulate what makes a particular course of action ethically defensible

CO 4: Assess their own ethical values and the social context of problems

Module 1: Effects of Technological Growth (12 hours)

Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development

Energy Crisis: Renewable Energy Resources

Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.

Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics.

Whistle blowing assembly line and automation. Human centered Technology.

Module 2: Ethics of Profession (12 hours)

Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and beyond, Case studies.

Module 3: Profession and Human Values (12 hours)

Values Crisis in contemporary society Nature of values: Value Spectrum of a good life

Psychological values: Integrated personality; mental health

Societal values: The modern search for a good society, justice, democracy, secularism, rule of law,

Values in Indian Constitution.
Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgments; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Text/ Reference Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)

2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.

3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta1996.

Haldia Institute of Technology, West Bengal

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2nd Year Curriculum Structure for B. Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: MC-EE 401	**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, basic concepts, 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. 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.

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.

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).

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.

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	-	-	-

Text/Reference Books:

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

4. Text Book for Environmental Studies, Erach Bharucha, UGC

5. Elements of Environmental Pollution Control, O.P. Gupta, Khanna Publishing House (AICTE Recommended Book).

Haldia Institute of Technology, West Bengal

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1st Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 491	**Category**: Professional Core Courses
Course Title: Electric Machine-I Laboratory	**Semester**: 4th
L-T-P :0-0-2	**Credit: 1**
Pre-Requisites: High school Physics (Theory and Laboratory), Circuit Theory, Basic Electrical Engg. (Lab and Theory)	
Course Outcomes:	
CO1:Recall relevant 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 on a single phase transformer
7. Determination of equivalent circuit of a single phase transformer and efficiency.
8. Study of different connections of three phase transformer.
9. Study of Parallel operation of a single phase transformer.
10. Determination of temperature rise and efficiency of the transformer. (Back to back test)

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	-	-	-
CO 2	3	2	2	3	2	2	2	1	-	1	2	1
CO 3	3	2	3	3	3	2	2	-	1	2	2	2
CO 4	3	3	2	2	2	2	3	1	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 Code: PC-EE 492	**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 Objectives:

- To learn basic techniques for the purpose of digital circuits and central concepts employed in the conception of digital systems.
- To understand different forms of number representation and to be able to convert between different number systems.
- Representation of the truth table of various expressions and combinational circuits using logic gates.
- Construction of Adder, Subtractor circuit in digital domain.
- Construction of flips-flops, counters, shift registers.
- Knowledge of Digital design for electronic appliances.

Course Outcomes:

CO1: Recall the convert numerical data to various number systems.

CO2:Underst and 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 of RS and JK Flip Flop circuit using logic gates.
4. Design of T and D Flip Flop circuit using logic gates.
5. Design of Register circuit using Flip Flop.
6. Design of serial to parallel converter and parallel to serial converter.
7. Design of asynchronous up/down counters.
8. Design of synchronous up/down counters.

9. 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	-	1	1	3	2	2
CO 2	3	2	1	3	2	1	1	1	1	3	2	3
CO 3	3	3	3	3	3	2	1	2	2	3	3	3
CO 4	3	2	2	2	3	1	1	1	2	3	3	3

CO & PSO Mapping:

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

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2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 493	**Category**: Professional Core Courses
Course Title: Electrical and Electronics Measurement Lab	**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 type ammeter/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

Haldia Institute of Technology, West Bengal

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

2nd Year Curriculum Structure for B.Tech courses in Engineering & Technology

(Applicable from the academic session 2020-2021)

Course Code: ES-ME 481	**Category**: Engineering Science Courses
Course Title: Thermal Power Engineering Lab	**Semester**: 4th
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Thermal Power Engineering	
Course Outcomes:	
CO 1: Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with thermal power operation.	
CO 2: Analyze the working and layout of different power plants and the different systems comprising the plant and discuss about its economic and safety impacts	
CO 3: Combine concepts of learnt courses to define the working principle boiler, its layout, safety principles and compare it with plants of other types.	
CO 4: Describe the working principle and basic components of the boiler and the economic and safety principles involved with it.	

List of Experiments:

1. Study of Cut Models – Boilers IC Engines
    - Lanchashire Boiler
    - Bahcock& Willcox Boiler
    - Cochran Boiler
    - Vertical Tubular Boiler
    - Locomotive Boiler
    - 4S Diesel Engine
    - 4S Petrol Engine
    - 2S Petrol Engine
2. Load Test on 4 Stroke Petrol Engine & Diesel Engine by Electrical Load Box.
3. Load Test on 4 Stroke Diesel Engine by Rope Brake Dynamometer.
4. Heat Balance on 4 Stroke Diesel Engine by Rope Brake Dynamometer & by Electrical Load Vs Box.
5. Valve Timing Diagram on 4S Diesel Engine Model & 4S Petrol Engine Model.
6. To find the Calorific Value of Diesel Fuel & Coal by Bomb Calorimeter.
7. To find the Flash Point & Fire Point of Petrol & Diesel Fuel.
8. To find the Cloud Point & Pour Point of Petrol & Diesel Fuel.
9. To find Carbon Particle Percentage in Diesel Engine Exhaust Smoke by Smokemeter and trace the BHP Vs. % Carbon Curve.
10. Measurement of the Quality of Steam – Enthalpy & Dryness fraction.
11. To find out the Boiler performance – Boiler efficiency & Steam evaporation rate.
12. To visit a Thermal Power Station & study of the followings :

- Boiler
- Steam pipe
- Furnace
- Economizer
- Preheater
- Steam turbines
- Alternator
- Water treatment plant
- E. S. P.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Course Code: PC-EE 501	**Category**: Professional Core Courses
Course Title: ELECTRICAL MACHINES – II	**Semester**: Fifth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Physics and Mathematics and Basic Electrical and Electronics Engineering	

Course Objectives :

- To make students conversant about the underlying energy conversion theory between electrical and mechanical systems by introducing electromechanical energy conversion principles.
- To expose the students to the concepts of various types of electrical machines and applications of electrical machines.
- To acquaint the student with the concept of generation of electricity in powerplant.

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: Developmathematical 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 (10 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 motor, Compensated & 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 (6 hours)

Principle and construction of switched Reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper motor, Tacho-generators, Synchronous& 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. Generalised 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 University press.
2. Performance & Design of A.C. Machines — M.G. Say, CBS Publishers&
3. Electric Machinery & Transformes, 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 Code: PC-EE 502	**Category**: Professional Core Courses
Course Title: Power Systems-I	**Semester**: 5th
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Power Electronics, Electrical Machine and Control System	

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: Bulk Power Grids and Micro-grids. Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems).

Module 2-Power System Components(14 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. Short, medium and long transmission lines. Insulators. Underground cables: structure, parameters and grading. Power Transfer, Voltage profile and Reactive Power. Surge Impedance Loading.

Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit
calculations.

Module 3-Over-voltages and Insulation Requirements (5 hours)

Generation of Over-voltages: Lightning and Switching Surges. Protection against Over-voltages, Insulation Coordination. Propagation of Surges. Travelling-wave Equations. Voltages produced by traveling surges. Bewley Diagrams.

Module 4-Fault Analysis and Protection Systems (13 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. Switchgear: Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes(Over- current, directional, distance protection, differential protection) and their application.

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/References:

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.

4. A text book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S. Bhatnagar& A. Chakrabarti, Dhanpat Rai & CO.

5. Elements of power system analysis, C.L. Wadhwa, New Age International.

6. Electrical Power System, Ashfaq Hussain, CBS Publishers &Distributors

Course Code: PC-EE 503	**Category**: Professional Core Courses
Course Title: Control System	**Semester**: 5th
L-T-P : 3L+1T	**Credit: 4**
Pre-Requisites: High school Physics, Mathematics and Circuit Theory	

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:(8 hours)

Introduction to control system: Elementary control concepts. Types of control systems. Open loop & closed loop systems. Concept of feedback and automatic control. Examples of feedback control system. Classification of feedback control system. Effects of feedback. Elementary concepts of sensitivity and robustness. Transfer function concept. Pole and Zeroes 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.

Module 2:(10 hours)

Time Domain Analysis: 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/Performanceindices.

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:(8 hours)

Frequency Response Analysis: 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 in Bode plot. Closed-loop frequency response.

Module 4:(8 hours)

Introduction to Controller Design and Compensation Techniques: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Application of Proportional, Integral and Derivative Controllers. Root-loci method of feedback controller design. Improvement of system performance through compensation. Lead and Lag compensation in designs. Design specifications in frequency-domain. Frequency-domain methods of design.

Module5: (6 hours)

State Variable Analysis: Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback.

Module6: (8 hours)

Introduction to Optimal Control and Nonlinear Control: Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.

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	2	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.

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

2. J. J. D’Azzo and C. H. Houpis, “Linear control system analysis and design (conventional and modern)”, McGraw Hill,1995.

3. R. T. Stefani and G. H. Hostetter, “Design of feedback Control Systems”, Saunders College Pub,1994

4. Nonlinear Control system, J.E. Gibson, Mc Graw Hill Book Co.

5. Digital Control & State Variable Methods, M. Gopal, 2nd Edition, TMH

6. Modern Control system, R.C. Dorf & R.H. Bishop, Pearson Education

Haldia Institute of Technology, West Bengal

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE-501A	**Category**: Open Elective Courses
Course Title: Data Structure and Algorithm	**Semester**: Fifth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Programming for problem solving, Mathematics	

Course Objectives:

1. To understand the basics of abstract data types.
2. To understand the principles of linear and nonlinear data structures.
3. To build an application using sorting and searching

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 (6 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 Technique sand 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 types of Queues: Algorithms and their analysis.

Module 3: (10 Hours)

Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, 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: (10 Hours) Sorting and Hashing: 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: Basic Terminologies 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, Sartaj Sahni, Susan Anderson freed, MIT press

4. Data Structures Using C, Reema Thareja. Oxford University press

5. Data Structure Using C, 2/e by A.K. Rath, A. K. Jagadev. SCITECH

6. Data Structures through C, Yashwant Kanetkar, BPB Publications.

Course Code: PE-EE-501A	**Category**: Professional Elective Courses
Course Title: Digital Signal Processing	**Semester**: Fifth
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 (8 hours)

Concept of 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-sample, unit step, unit ramp & complex exponentials, arithmetic operations on sequences.

Module 2 (4 hours)

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.

Module 3 (6 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, Perseval's relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises

Module 4 (6 hours)

Brief idea about the DSP, Review of Fourier Transform and Z-transform, 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, Circular Convolution, Properties of Circular Convolution, Sectioned convolution, Overlap-Save and Overlap-Add methods with examples and exercises, Fast Fourier Transform, Properties of FFT, Radix 2 Decimation in Time (DIT),

Module 5 (6 hours)

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

Module 6 (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, Frequency Transformations in the Analog domain, Frequency Transformations in the Digital domain.

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. RameshBabu
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. Fundamental 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, If each or, 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, Cengage Learning.
8. Digital Signal Processing, S. Salivahanan, A. Vallavaris & C. Gnanpruja, TMH.
9. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning
10. Xilinx FPGA user manual and application notes.

Course Code: PE-EE-501B	**Category**: Professional Elective Courses
Course Title: Computational Electromagnetic	**Semester**: Fifth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Electromagnet, Programming for problem solving, Mathematics	

Course Objectives:

- To understand the concepts of computational electromagnetics, to enable analysis of numerical stability and dispersion

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 Eigenvalue Problem, Space Eigenvalue 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 /Reference books:

1. Taflove, A. and Hagness, S.C., Computational Electrodynamics, Artech House (2006).
2. Sullivan, D.M., Electromagnetic Simulation Using the FDTD Method, IEEE Computer Society Press (2000).

Course Title: Economics for Engineers

Course Code: HM-EE 501	**Category**: Humanities
Course Title: Economics for Engineers	**Semester**: 5th
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 Code: PC-EE 591	**Category**: Professional Core Courses
Course Title: ELECTRICAL MACHINES -II LABORATORY	**Semester**: 5th
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Physics and Basic Electrical and Electronics Engineering (Theory and Laboratory)	
Course Objectives :	
• To expose the students to the operation of Synchronous machines and induction motors and give them experimental skills. • To give students practical laboratory experience with the basic of Synchronization in grid. • To introduce students to industrial control of electric machines as well with safe electrical connection and measurement practices.	
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: Construct an electrical experimental setup for gathering different electrical quantities and parameters for electrical machine operations.	
CO4: Inspect different characteristics generated from experimental data and analyse their performances.	

List of Experiments:

1. Different method of starting of 3 phase squirrel cage Induction motor & their comparison [D.O.L, Auto transformer &Star-Delta].
2. Speed control of 3 phase squirrel cage induction motor by different methods & their comparison [voltage control &frequency control]
3. Speed control of three phase slip ring Induction motor by rotor resistance control.
4. Determination of regulation of Synchronous machine by Potier-reactance method.
5. Determination of regulation of an Alternator by Synchronous Impedance method.
6. Determination of equivalent circuit parameters of a single phase Induction motor.
7. Load test on single phase Induction motor to obtain the performance characteristics.
8. To determine the direct axis reactance [Xd] & quadrature axis reactance [Xq] of three phase

synchronous machine by slip test.

9. Load test on wound rotor Induction motor to obtain the performance characteristics.
10. To make connection diagram of full pitch & fractional slot winding of 18 slot squirrel cage Induction motor for 6 pole & 4 pole operation.

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

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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 break down 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. Study of the characteristics of Overcurrent Relay.

11. Study of the characteristics of Undervoltage and Earth fault relay.
12. Dielectric constant, tan delta, resistivity test of transformer oil.

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 593	**Category**: Professional Core Courses
Course Title: Control System Laboratory	**Semester:** 5th
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 tool box, MATLAB- SIMULINK tool box &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 tool box 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. 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 pole will be in LHP or RHP. To verify (by simulation)that (i) with open loop stable pole, the response is slowed down for larger amplitude input (ii) for unstable plant, 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

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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 :	
CO 1: Ability to analyze algorithms and algorithm correctness	
CO 2: Ability to summarize searching and sorting techniques	
CO 3: Ability to describe stack, queue and linked list operation	
CO 4: 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.

Experiments mentioned above are not exhaustive. More experiments may be conducted.

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

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Course Code: PC-EE601	**Category**: Professional Core Course
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: Power Flow Analysis (8 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 2: Stability Constraints in synchronous grids (8 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. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

Module 3: 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 4: Monitoring and Control (6 hours)

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.

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/References:

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 602	**Category**: Professional Core Courses
Course Title: Power Electronics	**Semester**: Six
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical Engineering and 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: (6 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: PNPN devices (8 hours)

Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.

Module 3: Phase controlled converters (8 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 (5 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 (3 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. Bhimra, 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

3. Power Electronics, V.R. Moorthi, Oxford,2005

Course Code: PC-EE603	**Category**: Professional Core Courses
Course Title: Microprocessor and Micro-Controller	**Semester**: Sixth
L-T-P: 3-0-0	**Credit: 3**
Pre-Requisites: Physics and Mathematics and Basic Electrical and Electronics Engineering	

Course Objective:

- To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
- To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
- To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

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: INTRODUCTION TO MICROPROCESSOR(10 hours)

Architecture of a typical 8 bit 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 and flow chart, Introduction to assembly language & machine language programming,

Instruction set of typical microprocessors (e.g. 8085), Subroutine & stack, interrupt, Timing diagram, External Communication Interface, application in LED, LCD display, dc motor, stepper motor.

MODULE 2: 8086 MICROPROCESSORS (6 hours)

Introduction to 8086 Microprocessor, Architecture, addressing modes, Instruction set, Assembly language programming, 8086 System bus structure, 8086 signals.

Module 3: The 8051 Architecture (8 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, Timing diagrams
Module 4: Instruction Set and Programming (8 Hours) Basic instructions of 8051 microcontroller, assembly language and C language programming, timing diagrams, programming using loop, jump and call instruction, different addressing modes, branch instructions, subroutine instructions, arithmetic operations, logical operations, description of assembler, compiler, editor, debugger.
Module 5: 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).

Numerical problems are to be solved in the tutorial classes.

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:

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, “The8051Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education,2007.
4. K. J. Ayala, “8051 Microcontroller”, Delmar CengageLearning,2004.

References:

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.

4. B. Ram, “Fundamentals of microprocessors and microcomputers” Dhanpat Rai publications, 2012.

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(Applicable from the academic session 2020-2021)

Course Code: PE-EE 601A	**Category**: Professional Elective Courses
Course Title: Digital Control Systems	**Semester**: Sixth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Automatic Control, Microcontroller Systems	
Course Objective :	
• This course provides the students with the needed background for analyzing, designing, and implementing digital controllers. Emphasize will be given to real-time control of mechatronic systems.	
Course Outcome :	
CO 1: Understand the basic concepts of digital control theory.	
CO 2: Analyze and solve mathematical problems related to digital control theory.	
CO 3: Analyze the response of closed-loop systems.	
CO 4: Design digital controllers.	
Module 1: Introduction(4 hours) Review: Modeling and Analog Control	
Module 2: Sampled Data Systems and Z-Transform (10 Hours) Sampling Process; Linear Difference Equations; Z-Transform; Z-transform method for solving difference equations, Discrete Functions; Pulse Transfer Functions; Block Diagrams.	
Module 3: System Response Characteristics (6 Hours) Introduction, System Time Response, Time Domain Specifications; Mapping s-domain to z-domain, Steady State Accuracy.	
Module 4: Discrete equivalence (4 Hours) Bilinear Transformation; Zero-order-Hold; Pole-zero matching	
Module 5: System Stability(6 Hours) Introduction, The Routh Hurwitz Criterion, Jury’s Stability Test; Root Locus, The Nyquist Criterion.	
Module 6: Discrete Controller Design (8 Hours) Introduction, Control System Specifications, Digital Controllers; PID Controllers, PID Controller	

Design, Compensation, Design by Root Locus method, Design by Frequency Response method.
Module 7: State Variable Analysis (10 hours) Introduction, State Space Representation of discrete time systems, Pulse Transfer Function Matrix, Conversion of state variable model to transfer function. Solution of discrete time state space equations, State transition matrix and it's Properties, Discretization of continuous time state – space models, Controllability and Observability, Principle of Duality, Liapunov stability analysis.

Numerical problems are to be solved in the tutorial classes.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Text/Reference Books:

1. Digital Control of Dynamic Systems by Franklin, Powel, and Workman. 3rd edition. Addison-Wesley Publisher
2. Digital Control Systems: Design, Identification, and Implementation by Landau and Zito. Springer 2006
3. Discrete-Time Control Systems by K. Ogata, Prentice-HallInternational, Inc.
4. Digital Control and State Variable Methods, M. Gopal, TMH Publication.
5. Digital Control System Analysis and Design, Charles L. Philips and H. Troy Nagle, Prentice Hall.

Course Code: PE-EE 601B	**Category**: Professional Elective Courses
Course Title: Advanced Control System	**Semester**: Sixth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Basic knowledge of Control system and Physical system	
Course Objectives :	
• To learn the advanced methods for analyzing the behavior of control systems and designing of control systems.	
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 Feedback Control(8 hours) Introduction, Pole Placement Design, Full Order Observer Design, Separation principle and Reduced Order Observer, Liapunov stability analysis.	
Module 1: Nonlinear Control Systems(8 hours) Introduction to Nonlinear systems and their properties, Common Non-linearities, Describing functions, Phase plane method, Lyapounov's method for stability study, concept of Limit Cycle	
Module 2: Optimal Control Theory(4 Hours) Introduction, Optimal control problems, Mathematical procedures for optimal control design: Calculus of variations, Pontryagin's optimum policy, Bang-Bang Control, Hamilton-Jacobi Principle	
Module 3: Sliding Mode Control(6 Hours) Introduction and the concept, Sliding surface, Equivalent Control.	
Module 3: z-Plane Analysis of Discrete-Time Control Systems(4 Hours) Introduction, Impulse sampling and data hold, Reconstructing original signal from sampled signals, concept of pulse transfer function, Realization of digital controllers.	
Module 4: Design of Discrete-time Control Systems(6 Hours) Introduction, Stability analysis of closed-loop systems in the z-plane, Transient and steady state response analysis, Design based on the root-locus method, Design based on the frequency response method.	

Numerical problems are to be solved in the tutorial classes.

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/Reference 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).
4. Sliding Mode Control – Theory and Applications, Christopher Edwards and Sarah K. Spurgeon, CRC Press.
5. Digital Control and State Variable Methods , M. Gopal, TMH Publication.
6. Control Systems Engineering, I. J. Nagrath and M. Gopal, New Age International Publishers.

Haldia Institute of Technology, West Bengal

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE601A	**Category**: Open Elective Courses
Course Title: Database Management Systems	**Semester**: Sixth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: DBMS and computer knowledge	

Course Objectives :

- The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
- To explain basic database concepts, applications, data models, schemas and instances.
- To demonstrate the use of constraints and relational algebra operations.
- Describe the basics of SQL and construct queries using SQL.
- To emphasize the importance of normalization in databases.
- To facilitate students in Database design
- To familiarize issues of concurrency control and transaction management.

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 subqueries, Data base security application development using SQL, Stored procedures and triggers.
Module 5: Relational Database design(4 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 (8 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 6: File organization & index structures (4 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 bhattacharjya, Tata Mc Graw Hill.

Course Code: OE-EE601B	**Category**: Open Elective Courses
Course Title: Object Oriented Programming	**Semester**: Sixth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Codes basic programs in Java programming language	
Course Objectives :	
• Defines arrays in Java and uses them • Makes relational operations in Java	
Course Outcomes :	
CO 1: Codes basic programs in Java programming language	
CO 2: Apply knowledge and Makes relational operations in Java	
CO 3: Defines arrays in Java and uses them	
CO 4: Analyze and Uses objects and classes	
Module 1: Object oriented Design(10 hours) Concept of Object oriented programming language, Major and minor elements, Object, Class, relationship among objects, aggregation, links, relationship among classes association, aggregation using instantiation, meta-class, grouping constructs.	
Module 2: Object oriented concept (4 Hours) Difference between OOP and other conventional programming, advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism	
Module 3: Basic concepts of Object oriented programming using Java (22 Hours) **Class & Object properties**: Basic concepts of Java programming-advantages of Java, bytecode& JVM, data types, access specifies, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, garbage collection, nested and inner classes, basic string handling concepts, -String (discuss char(), compare(), equals(),equals Ignore case(), index Of(), length(), substring(), to CharArray(), to LowerCase(), tostring(), methods), concept of mutable and immutable string, command line arguments, basics of I/O operations-keyboard input using Buffered Reader & Scanner classes. **Reusability properties**: Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, use of abstract classes, & methods, interfaces. Creation of packages, importing packages, member access for packages. **Exception handling & Multithreading**: Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user define dexception classes.	

Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread synchronization, inter thread communication, deadlocks for threads, suspending & resuming threads.

CO & PO Mapping:

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

Text Books:

1. Object Oriented Modeling and design, James Rambaugh& Michael Blaha, PHI.
2. Object Oriented Programming with C++ and Java, D. Samanta, PHI
3. Programming with Java: A Primer, E. Balagurusamy, TMH.

Reference Books:

1. Object oriented system Development, Ali Bahrami, Mc Graw Hill.
2. The complete reference Java2, Patrick Naughton & Herbert Schildt, TMH

Course Code: OE-EE601C	**Category**: Open Elective Courses
Course Title: Data Science with Python	**Semester**: Sixth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Knowledge of basic data science algorithms, Python, C, C++, Object Oriented Programming	

Course Objectives :

- Basic process of data science
- Python and Jupyter notebooks
- An applied understanding of how to manipulate and analyze uncurated datasets
- Basic statistical analysis and machine learning methods
- How to effectively visualize results

Course Outcomes :

CO 1: Develop relevant **programming** abilities.

CO 2: Demonstrate proficiency with statistical **analysis of data**.

CO 3: Develop the ability to build and assess data-based **models**.

CO 4: Execute statistical analyses with professional statistical **software**.

Module 1: Introduction to Programming (4 hours)

History of Computers, Understanding Hardware Writing First Program

Variables & Data Types: Strings, Integers, Integers, Floats, Boolean, etc., Assigning Variables, Operators

Module 2: Control Flow (4 Hours)

Define motivation behind control flow If, If-Else, Elif, Switch Statements

Complex Data Types: Initializing Lists, Printing Lists, List functions such as length, append, pop, etc., Introduction to Dictionaries & their structures

Loops: Define the motivation behind using a loop, For While, Do-While, For Each loops Error Handling

Functions: Identify when to use a function, Syntax & Implementation, Arguments & Return values

Module 3: Object Oriented Programming (6 Hours)

Introduction to O.O.P paradigm, Introduction to Objects, Classes, Instances Inheritance, Abstraction, and Sets

Module 4: Advanced Python (6 Hours)

File Input, User Input, List Comprehension, Packages

Module 5: Data Science (6 Hours) Introduction to Data Science, Review Python Fundamentals, Understanding the data science discipline, Pandas, Data set reading Filtering, Cleaning, Manipulating Data, Excel vs Python **Data Visualization**: Matplotlib Package, Understanding motivations between different graphs
Machine Learning: Sci-Kit Learn package, Understand motivation and definition of machine learning
Module 6: Internal of RDBMS (6 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 6: File organization & index structures (4 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	**1**	2	1	1	1	1	-	-	1	1	1	1
CO 2	2	2	2	1	2	2	-	-	2	1	1	3
CO 3	1	2	1	1	2	2	-	-	2	2	2	2
CO 4	1	3	2	3	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	1	2
CO 4	1	1	1

Text/ Reference Books:

1. Intro to Python for Computer Science and Data Science by by Harvey Deitel, PAUL. DEITEL DEITEL (HARVEY.), and Paul Deitel

2. Python Data Science Handbook: Essential Tools for Working with Data By Jake VanderPlas

3. Data Mining and Analysis: Fundamental Concepts and Algorithms By Mohammed J. Zaki & Wagner Meira, JR.

Course Code: HM-EE603	**Category**: Humanities Courses
Course Title: Principle of Management	**Semester**: Sixth
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Basic level of management	

Course Objectives :

- To help the students gain understanding of the functions and responsibilities of managers
- To provide them tools and techniques to be used in the performance of the managerial job
- To enable them to analyze and understand the environment of the organization
- To help the students to develop cognizance of the importance of management principles

Course Outcomes :

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: Basic concepts of management (12 Hours)

Definition – Essence, Functions, Roles, Level.

Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organization Structure –Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness

Module 2: Management and Society (12 Hours)

Concept, External Environment, CSR, Corporate Governance, Ethical Standards.

People Management – Overview, Job design, Recruitment & Selection, Training &Development, Stress Management. Managerial Competencies – Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship

Module 3: Leadership(6 Hours)

Concept, Nature, Styles.

Decision making: Concept, Nature, Process, Tools & techniques.

Economic, Financial & Quantitative Analysis – Production, Markets, National Income Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.

Module 4: Customer Management (6 Hours)

Market Planning & Research, Marketing Mix, Advertising &Brand Management.
Operations & Technology Management – Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.

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/ Reference Books:

1. Management: Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz, Revised edition, Tata McGraw Hill (TMH)
3. Management – Stoner, James A. F. (Pearson)
4. Management - Ghuman, Tata McGraw Hill(TMH)

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

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. Formation of Bus Admittance Matrix.
2. Study of AC load flow using Gauss-Seidal Method.
3. Study of AC load flow using Newton-Raphson Method.
4. Study on Economic Load Dispatch.
5. Transient stability analysis of single machine connected to infinite bus.
6. Voltage control using STATCOM.
7. Study on the reliability of power system using Power world.
8. Automatic Generation Control using Simulink.
9. Study the effect of transformers in power flow.
10. 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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PC-EE 692	**Category**: Professional Core Courses
Course Title: Power Electronics Laboratory	**Semester**: Six
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:

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a TRIAC.
3. Study of different triggering circuits of an SCR
4. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
5. Study of performance of single phase half controlled bridge converters.
6. Study of performance of step down chopper.
7. Study of performance of step up chopper.
8. Study of performance of PWM bridge inverter.
9. Study of performance of single phase controlled converter (simulation).
10. Study of performance of three phase controlled converter (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 Code: PC-EE 693	**Category**: Professional Core Courses
Course Title: Micro-processor and Microcontroller laboratory	**Semester:** 6th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Physics and Basic Electrical and Electronics Engineering (Theory and Laboratory)	
Course Objectives: • To expose students to the operation of typical microprocessor (8085) trainer kit. • To prepare the students to be able to solve different problems by developing different programs. • To develop the quality of assessing and analyzing the obtained data.	
Course Outcomes:	
CO1: Relate relevant information of the course Microprocessor and Microcontroller for performing different laboratory experiments.	
CO2: Familiarize with different kits and softwares 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/simulator, process of storing and viewing of data.
2. Assembly language programming to add or subtract two 8-bit numbers using 8085 trainer kit/simulator.
3. Assembly language programming for different logical operations (viz. AND, OR, XOR) using 8085 trainer kit/simulator.
4. Assembly language programming to find the largest or smallest number among a group of 8-bit numbers using 8085 trainer kit/simulator.
5. Assembly language programming to sequence a group of number in ascending or descending order using 8085 trainer kit/simulator
6. Assembly language programming for Addition of three or more 8- bit numbers using 8085 trainer kit/simulator.
7. Assembly language programming to transfer a block of data from one set of memory locations to the other, using 8085 trainer kit/simulator.
8. Assembly language programming to find out the square or square root of a number from look up table using 8085 trainer kit/simulator.
9. Assembly language programming to convert BCD to Hexadecimal using 8085 trainer kit/simulator.

10. Assembly language programming to convert ASCII to Hexadecimal using 8085 trainer kit/simulator.
11. Assembly language programming using 8085 trainer kit/simulator to interface Traffic light/ 7 segment display/ Stepper motor.
12. Familiarization with 8086 Microprocessor trainer kit/Simulator.
13. Familiarization with 8051 Microcontroller trainer kit/Simulator.
14. Assembly language programming for Addition/ Subtraction using 8051 trainer kit/simulator.
15. Assembly language programming for Multiplication/ Division using 8051 trainer kit/simulator.

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 691 A	**Category**: Open Elective Courses
Course Title: Database Management Systems Laboratory	**Semester**: Six
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Basic database concepts, applications, data models, schemas and instances	
Course Outcomes:	
CO 1: Apply the basic concepts of Database Systems and Applications	
CO 2: Use the basics of SQL and construct queries using SQL in database creation and interaction	
CO 3: Design a commercial relational database system (Oracle, MySQL) by writing SQL using the System	
CO 4: 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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 691B	**Category**: Open Elective Courses
Course Title: Object Oriented Programming laboratory	**Semester:** 6th
L-T-P: 0-0-2	**Credit: 1**
Pre-Requisites: Codes basic programs in Java programming language	
Course Objectives:	
• Defines arrays in Java and uses them • Makes relational operations in Java	
Course Outcomes:	
CO 1: Codes basic programs in Java programming language	
CO 2: Apply knowledge and Makes relational operations in Java	
CO 3: Defines arrays in Java and uses them	
CO 4: Analyze and Uses objects and classes	

List of Experiments:

1. Assignments on class, constructor, overloading, inheritance, overriding
2. Assignments on wrapper class, arrays
3. Assignments on developing interfaces- multiple inheritance, extending interfaces
4. Assignments on creating and accessing packages
5. Assignments on multithreaded programming
6. Assignments on applet programming

Note: Use Java for programming Preferably download "java_ee_sdk-6u4-jdk7-windows.exe" fromhttp://www.oracle.com/technetwork/java/javaee/downloads/java-ee-sdk-6u3-jdk-7u1-downloads-523391.html

CO & PO Mapping:

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 691C	**Category**: Open Elective Courses
Course Title: Data Science with Python Laboratory	**Semester:** 6th
L-T-P : 0-0-2	**Credit: 1**
Pre-Requisites: Knowledge of basic data science algorithms, Python, C, C++, Object Oriented Programming	
Course Objectives :	
• Basic process of data science • Python and Jupyter notebooks • An applied understanding of how to manipulate and analyze uncurated data sets • Basic statistical analysis and machine learning methods • How to effectively visualize results	
Course Outcomes :	
CO 1: Install python on windows/ ubuntu operating system. Use editor- pycharm to execute python Programs	
CO 2: Use operations on lists, tuples, sets, dictionary data types to solve given programing problem.	
CO 3: Apply object-oriented concepts in python programing to solve given real world problem.	
CO 4: Analyze mathematical and simple real world problems and device programming solutions using python programming language.	

List of Experiments:

1. Python and Pycharm Installation

2. Python Lists
3. Python Sets
4. Python Dictionary
5. File Handling
6. Exception Handling
7. Testing
8. Object Oriented Programming
9. Self Study and creative presentation

CO & PO Mapping:

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE701A	**Category**: Professional Elective Courses
Course Title: Electrical Drives	**Semester**: 7th
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 toques, 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) Stating of Electric Drives: Effect of starting on Power supply, motor and load. Methods of stating 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. 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, 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 InternationalPublication.
2. Electric Drives, VedamSubrahmanyam,TMH
3. A first course on Electrical Drives, S.K. Pillai, , New Age InternationalPublication.

Reference Books:

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 702A	**Category**: Professional Elective Courses
Course Title: High Voltage Engineering	**Semester**: 7th
L-T-P:3-1-0	**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 (10hours)

Breakdown of Gases: Mechanism of Breakdown of gases, 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 break down, Thermal breakdown, Streamer Breakdown.

Breakdown of Liquid: Intrinsic Break down, 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 (10 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 InternationalPublishers.
2. High Voltage Engineering, M.S. Naidu & V. Kamraju, Tata MC Graw Hillpublication.
3. Book of Bgamude.

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.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 702B	**Category**: Professional Elective Courses
Course Title: Utilization of Electric power	**Semester**: 7th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic knowledge on Electric Machine, Basic concepts of different laws on Electrostatic and Electromagnetism	

Course Objective:

- To understand the basic principles of light control and types of light schemes.
- To impart how to design the traction system considering economic and technology up gradation.

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 (16 hours)

Requirement of an ideal traction system, Supply system for electric traction, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed), Mechanism of train movement (energy consumption, tractive effort during acceleration, tractive effort on a gradient, tractive effort for resistance, power & energy output for the driving axles, factors affecting specific energy consumption, coefficient of adhesion).

Electric traction motor & their control: Parallel and series operation of Series and Shunt motor with equal and unequal wheel diameter, effect of sudden change of in supply voltage, Temporary interruption of supply, Tractive effort and horse power.

Use of AC series motor and Induction motor for traction.

Traction motor control: DC series motor control, Multiple unit control, Braking of electric motors, Electrolysis by current through earth, current collection in traction system, Power electronic controllers in traction system.

Module 2: Illumination(8 hours) The nature of radiation, Polar curve, Law of illumination, Photometry (Photovoltaic cell, distribution photometry, integrating sphere, brightness measurement), Types of Lamps: Conventional and energy efficient, Basic principle of light control, Different lighting scheme & their design methods, Flood and Street lighting.
Module 3: Electric Heating welding(8 hours) Types of heating, Resistance heating, Induction heating, Arc furnace, Dielectric heating, Microwave heating.
Module 4: Electrolytic processes(4 hours) Basic principles, Faraday's law of Electrolysis, Electro deposition, Extraction and refining of metals, Power supply of Electrolytic processes.

Numerical problems are to be solved in the tutorial classes.

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 / Reference 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.

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 702C	**Category**: Professional Elective Courses
Course Title: Advanced Power Systems	**Semester**: 7th
L-T-P:3-1-0	**Credit: 3**
Pre-Requisites: Power System, power system Control	
Course Outcomes:	
CO 1: To discuss different techniques dealing with sparse matrix for large scale power systems.	
CO 2: To explain different methods of power flow solutions.	
CO 3: To solve optimal power flow problem.	
Module 1: Objectives of Power System Operation (6hours) Power Systems in Restructured Environment; Distributed and Dispersed Generation; Environment Aspects of Electric Power Generation.	
Module 2: Economic Operation of Energy Generation Systems(10 hours) Generation Cost Curves; Economic Operation of Thermal System; Plant Scheduling; Transmission Loss and Penalty Factor; Hydro-Thermal Scheduling; Concept of Reserves and Constraints; Unit Commitment.	
Module 3: Automatic Generation Control(8 hours) Concept of AVR and ALFC Loops, Significance of Double Loop in ALFC; Exciter and VAR Control; Single Area Load Frequency Control; Two Area Load Frequency Control; Frequency Response.	
Module 4:Compensation in Power System(8 hours) Reactive Power Sensitivity and Voltage Control; Load Compensation with Capacitor Banks; Line Compensation with Reactors; Shunt and Series Compensation; Fixed Series Capacitors; Thyristor Controlled Series Capacitors; Introduction to SVC and STATCOM.	
Module 5: Power System Transients(8 hours) 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	1	3	3	3	3	-	-	-	-	-	3	3
CO 2	1	3	2	3	3	-	-	-	-	-	3	3
CO 3	3	3	3	1	1	-	-	-	-	-	1	3
CO 4	1	2	3	3	3	-	-	-	-	-	3	3

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

Text Books:

1. Power System Engineering, Kothari & Nagrath, Mc Graw Hill
2. Power System Analysis, Granger and Stevension, Mc Graw Hill
3. Electric Power Genration operation and control, Wood and Woolenberg, Willey.

Reference Books:

1. Power system stability and Control, P. Kundur , Mc Graw Hill
2. Modern power system analysis, Kothari & Nagrath, Mc.Graw Hill
3. Power system Analysis, Nagsarkar& Sukhija, Pearson
4. Power system analysis, operation and control, Chakrabarti and Halder, PHI
5. Book of Elgand.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 702D	**Category**: Professional Elective Courses
Course Title: Embedded System	**Semester**: 7th
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.	
Module: 2 PIC Microcontroller (6 hours) PIC Microcontrollers: 16F877 Architecture and Instruction Set. External Interrupts, Timers, watch-dogtimer, 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	
Module: 4 Basic design using a real time operating system(8 hours) Overview. General principles. Design of an embedded system.	

Module: 5 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 Kamal TMH, 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, Newnes,
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.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 701A	**Category**: Open Elective Courses
Course Title: Computer Networking	**Semester**: 7th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Computer Knowledge, Hardware and software network	

Course Objectives:

- Describe how computer networks are organized with the concept of layered approach.
- Implement a simple LAN with hubs, bridges and switches.
- Describe how packets in the Internet are delivered.
- Analyze the contents in a given Data Link layer packet, based on the layer concept.
- Design logical sub-address blocks with a given address block.

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 sub layer:

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(10 hours)

Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, sub netting; Routing : techniques, static vs. dynamic routing , Unicast Routing Protocols: RIP, OSPF, BGP; Other Procols: 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(6 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.

Numerical problems are to be solved in the class.

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 Rose Pearson Education
2. Communication Networks, Leon, Garica, Widjaja, TMH
3. Communication Networks, Walrand, TMH.
4. Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.), Comer, Pearson Education/PHI

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 701B	**Category**: Open Elective Courses
Course Title: Artificial Intelligence and Machine Learning	**Semester**: 7th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic math, Science and Computer programming	

Course Objective:

- To provide a strong foundation of fundamental concepts in Artificial Intelligence and Machine Learning
- To provide a basic exposition to the goals and methods of Artificial Intelligence and ML
- To enable the student to apply these techniques in applications which involve perception, reasoning and learning

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(4hours)

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 (8 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 (2 hours) Decision on Clustering and Classification algorithms, Naïve Bayes Theorem, Decision Tree, SVM.
Module 7:Applications (6 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, 2nd Edition, Pearson Education / Prentice Hall of India, 2004.
2. 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.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 702A	**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 (8 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(8 hours) General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers 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

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 (9 hours)

Principles of nuclear energy, Lay out 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 (5hours)

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.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 702B	**Category**: Open Elective Courses
Course Title: Renewable Energy	**Semester**: 7th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Engineering Thermodynamics, Thermal Power Engineering, Machine I & II	
Course Objectives: • To introduce students to different aspects of power plant engineering. • To familiarize the students to the working of power plants based on different fuels. • To expose the students to the principles of safety and environmental issues.	
Course Outcomes:	
CO1: Remember the different sources of energy prevailing around the globe to generate power.	
CO2: Explain the 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(3 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 environment, Kyoto Protocol.
Module 2: Solar Energy (8 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 driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - 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 (5 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 (3 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
Module 5: Geothermal Energy (3 hours) 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.
Module 6: Energy from Ocean (3 hours) 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.
Module 7: Magneto Hydrodynamic power generation(3 hours) Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.
Module 8: Hydrogen Energy(3 hours) Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.
Module 9: Fuel cell(5hours) Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells

Numerical problems to be solved in the class.

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.

Reference Books:

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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 702C	**Category**: Open Elective Courses
Course Title: Electric Vehicle Technology	**Semester**: 7th
L-T-P:3-0-0	**Credit: 3**
Pre-Requisites: Basic Electrical and Electronics Engineering	

Course Objective:

- To introduce students to different aspects of EV.
- To familiarize the students to the operation of EV along with charging systems.
- To expose the students to the principles of safety and environmental issues.

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(8hours)

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 (8hours)

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 (6hours)

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 (6hours)

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/ Reference 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
4. Tariq Muneer and Irene Illescas García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017

Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: OE-EE 702D	**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 systemin 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.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE-791A	**Category:** Professional Elective Courses
Course Title: Electrical Drives Laboratory	**Semester:** 7th
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:

a. Study of thyristor controlled DC Drive.

b. PWM Inverter fed 3 phase Induction Motor control

c. Dynamic braking operation for DC Motor - Study using PSIM software

d. Regenerative braking operation for DC Motor - Study using PSIM software.

e. Single phase rectifier fed DC Motor- Study using PSIM software

f. Buck Chopper fed DC Motor- Study using PSIM software

g. Three phase SPWM inverter fed Three phase induction motor-study using PSIM 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: 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
Course Title: Project-I	**Semester**: 7th
L-T-P:0-0-6	**Credit: 3**
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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: HM-EE 801	**Category**: Humanities
Course Title: Organizational Behaviour	**Semester**: 8th
L-T-P : 2-0-0	**Credit: 2**
Pre-Requisites: Basic concept of management, Leadership skill	
Course Outcomes:	
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.	
Module 1: Organizational Behaviour(2 hours) Definition, Importance, Historical Background, Fundamental Concepts of OB,Challenges and Opportunities for OB.	

Module 2: Personality and Attitudes (2 hours) Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction.
Module 3: Perception (2 hours) Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making.
Module 4: Motivation (4 hours) Definition, 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.
Module 5:Group Behaviour(2 hours) Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making.
Module 6:Communication (2 hours) Communication Process, Direction of Communication, Barriers to Effective Communication.
Module 7:Leadership (2 hours) Definition, Importance, Theories of Leadership Styles.
Module 8:Organizational Politics (2 hours) Definition, Factors contributing to Political Behaviour.
Module 9:Conflict Management (2 hours) Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process.
Module 10:Organizational Design (4 hours) Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture.

Text / Reference Books:

1. Robbins, S. P. & Judge, T.A.: Organizational Behavior, Pearson Education, 15 th Edn.
2. Luthans, Fred: Organizational Behavior, McGraw Hill, 12 th Edn.
3. Shukla, Madhukar: Understanding Organizations – Organizational Theory & Practice in India, PHI
4. Fincham, R. & Rhodes, P.: Principles of Organizational Behaviour, OUP, 4 th Edn.
5. Hersey, P., Blanchard, K.H., Johnson, D.E.- Management of Organizational Behavior Leading Human Resources, PHI, 10 th Edn.

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE- EE 801A	**Category**: Professional Elective Courses
Course Title: HVDC Transmission	**Semester**: 8th
L-T-P : 3-1-0	**Credit: 3**
Pre-Requisites: Power System Fault, Power Electronics Devices, Converters, Inverters, Compensating Devices	

Course Objective:

- To introduce students with the concept of HVDC Transmission system
- To familiarize the students with the HVDC converters and their control system
- Toexposethestudentstotheharmonicsandfaultsoccurinthesystemandtheirprotectionagainstover currents and over voltages, filter units, Surge arresters, smoothing reactors.

Course Outcomes:

CO 1:To acquire knowledge of HVDC transmission and different converters, applicability and advantage of HVDC transmission over conventional AC transmission.

CO 2: Formulate and solve mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC links Able to identify the procedures for calculations of different circuit parameters.

CO 3: Analyze the different harmonics generated by the converters and their variation with the change in firing angles and overlap angle.

CO 4: Develop harmonic models and use the knowledge of circuit theory to develop filters and assess the requirement and type of protection for the filters.

Module 1: INTRODUCTION (8 Hours)

Introduction of DC power transmission technology, comparison of AC and DC transmission, advantages of HVDC transmission, limitation of HVDC transmission, reliability of HVDC systems, application of DC transmission, description of DC transmission system, planning for HVDC transmission, modern trends in DC transmission.

Module 2: ANALYSIS OF HDVC CONVERTERS (8 Hours)

Choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, Characteristics of a twelve pulse converter, detailed analysis of converters.

Module 3: CONTROL OF HVDC CONVERTER AND SYSTEMS(8 Hours)

Principles and necessity of a DC link control, Converter control characteristics, System control hierarchy, inverter extinction angle control, pulse phase control, Effect of source inductance on the system, Starting and stopping of DC link, constant power control, control scheme of HVDC converters.

Module 4: HARMONICS AND FILTERS(4 Hours)

Generation of harmonics by converters, characteristics of harmonics on DC side, characteristics of current harmonics, characteristic variation of harmonic currents with variation of firing angle and overlap angle, effect of control mode on harmonics, non-characteristic harmonic. Harmonic model and equivalent circuit, use of filter, filter configuration, design of band pass and high pass filter, protection of filters, DC filters, power line communication and RI noise, filters with voltage source converter HDVC schemes.

Module 5:FAULT AND PROTECTION SCHEMES IN HVDC SYSTEMS(4 Hours)

Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units, Surge arresters, smoothing reactors.

Module 6:MULTI TERMINAL HVDC SYSTEMS(4 Hours)

Types of multiterminal (MTDC) systems, parallel operation aspect of MTDC. Control of power in MTDC. Multilevel DC systems. Power upgrading and conversion of AC lines into DC lines, Parallel AC/DC systems, FACTS and FACTS converters.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Text Books:

1. HVDC Transmission, S. Kamakshaiah& V. Kamaraju, Tata McGraw hill education
2. HVDC Power transmission system, K.R.Padiyar, Wiley Eastern Limited
3. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers
4. EHVAC and HVDC Transmission Engineering and Practice –S.Rao
5. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand& Company

Reference Books:

1. The Performance, Operation and Control of EHV Power Transmission Systems, A. Chakraborty,

D.P.Kothary, A.K. Mukhopadhyay, Wheeler Pub
2. High Voltage Direct Current Transmission, J. Arrillaga, Peter Pregrinu. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, New Age International (P)Ltd
3. High Voltage Direct Current Power Transmission, Colin Adamson and N.G.Hingorani, Garraway Limited, London

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 801B	**Category**: Professional Elective Courses
Course Title: Energy management & audit	**Semester**: 8th
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Basic understanding about energy consumption patterns	

Course Objectives:

- To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of energy conservation and energy auditing.
- To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding energy conservation and energy auditing.

Course Outcomes:

CO1: Recall the key concepts of energy generation, consumption and economics.

CO2: Explain the principles of energy consumption, management, efficiency and interpret the relationship between energy management and sustainable practices.

CO3: Develop knowledge on the present energy environment scenario, energy conservation regulations, energy audit 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(6 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 (4 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		1	1	1	1	1		1				1
CO 2	2	2	2	2	2	2	2		2		2	2
CO 3	3	2	2	2	1	2	2		2	2		2
CO 4	2	3	3	3	2	3	3	2	3	3	3	3

CO & PSO Mapping:

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

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

Haldia Institute of Technology, West Bengal

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 801C	**Category**: Professional Elective Courses
Course Title: Illumination Engineering	**Semester**: 8th
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Physics, Source of Light, Electrical Energy	

Course Objectives:

- To provide an introduction to the fundamentals of illumination engineering and architectural lighting design.
- To impart lighting fundamentals, measurement, and technology and their application in the analysis and design of architectural lighting systems

Course Outcomes:

CO 1: Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor Space

CO 2: Perform calculations on photometric performance of light sources and luminaries for lighting design.

CO 3: Evaluate different types of lighting designs and applications

CO 4: To part knowledge about the different types of lamps.

Module 1: Light, sight & color(6 hours)

Sources of light: Day light, artificial light sources, energy radiation, visible spectrum of radiation, black body radiation and full radiator. Incandescence, dependence of light o/p on temperature. Theory of gas discharge and production of light. Perception of light and color, optical system of human eye,
eye as visual processor. Reflection, refraction and other behavior of light.

Module 2: Measurement of light (6 hours) Measurement of light - radiometric and photometric quantities, units of measurement, standardization. Measurement of light distribution, direct and diffused reflection, fundamental concepts of Colourimentry and measurement of colour.
Module 3: Lamp, accessories & luminaries (12 hours) Light production by gas discharge, fluorescence, incandescence, daylight principle of operation, light efficacy, color, electrical characteristics, typical applications, dimming condition of GLS filament, tungsten halogen lamps, fluorescent tubes, compact fluorescent lamp (CFL), low and high pressure sodium lamps, high pressure mercury lamp, metal halide lamp. Functions of luminaries, classification, Materials Used in luminaries manufacturing, reflection, refraction, diffusion, polarization and optical design, photometric measurements, application data and its use. LED.
Module 4: Interior lighting (8 hours) Objectives quantity and quality of light, selection of lamps, luminaries section, placement. Design considerations for lighting of offices, conference rooms, hospitals, teaching places, house etc., design calculations.
Module 5: Lighting control (4 hours) Types of lighting controls, strategy for selection, benefits of lighting control. Electric distribution system for lighting, maintenance strategies, group replacement schedule. Techniques of achieving energy efficient lighting design, role of computers in lighting design, advantages and limitations of computer aided lighting design.

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 / Reference Books:

1. Utilization of Electric Power, C.L. Wadha, New Age International Ltd.
2. Generation, Distribution and Utilization of electrical energy, C.L. Wadha, New Age International Ltd.
3. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.
4. Standard Hand Book for Electrical Engineers, Fink & Beaty, McGraw Hill International.

Haldia Institute of Technology, West Bengal

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE801D	**Category**: Professional Elective Courses
Course Title: Sensors and Transducers	**Semester**: 8th
L-T-P : 3-0-0	**Credit: 3**
Pre-Requisites: Applied Physics, Basics of sensing elements	

Course Objective:

- To gain knowledge about the measuring instruments and the methods of measurement and the use of different transducers

Course Outcomes:

CO 1: Explain the classification and static characteristics of transducers.

CO 2: Describe various measurement standards and various errors and perform error analysis.

CO 3: Obtain and analyze dynamic characteristics of transducer.

CO 4: Describe construction, working principle, characteristics and applications of various resistance transducers.

Module 1: Mechanical and Electromechanical sensor(12 hours)

Definition, principle of sensing & transduction, classification.

Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity.

Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.

Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetstrictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis.

LVDT: Construction, material, output input relationship, I/O curve, discussion.

Proximity sensor.

Module 2: Capacitive sensors (8 hours)

Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics. Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force& stress
sensing, ultrasonic sensors.

Module 3: Thermal sensors (10 hours)

Material expansion type: solid, liquid, gas & vapor
Resistance change type: RTD materials, tip sensitive &stem sensitive type, Thermister material, shape, ranges and accuracy specification.
Thermo emf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type.
Radiation sensors: types, characteristics and comparison. Pyroelectric type.

Module 4: Magnetic sensors (6 hours)

Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics.
Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response.
Geiger counters, Scintillation detectors, Introduction to smart sensors.

Numerical problems are to be solved in the class.

CO & PO Mapping:

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

CO & PSO Mapping:

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

Text / Reference Books:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI
2. Instrument transducers, H.K.P. Neubert, Oxford University press.

3. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill.

Course Code: Project-II

Course Code: PR-EE881	**Category**: Project
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: Compare and 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

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Curriculum Structure for B.Tech courses in Electrical Engineering

(Applicable from the academic session 2020-2021)

Course Code: PE-EE 881	**Category**: Professional Elective Courses
Course Title : Electrical Systems Design	**Semester**: Eight
L-T-P : 0-0-3	**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 Note Book (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, RCB, RCBOMPCB)
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

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

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

Course Title: Comprehensive Viva Voce

Course Code: SE-EE882	**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	1	1	-	1	3	1	-	2	3	1	1
CO 2	3	1	-	-	-	2	-	-	2	3	1	1
CO 3	3	1	-	1	1	2	-	-	2	3	1	2
CO 4	3	1	-	-	-	2	-	1	3	3	2	1

CO & PSO Mapping:

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

Course Title: Internship-II

Course Code: SE-EE883	**Category**: Project, Seminar, Industrial Visit (Sessional)
Course Title: Seminar on Internship	**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

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 Techniquesin SignalProcessing	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

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
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

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
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/

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
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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Confirmation/Approval:

The proposed syllabus has been approved by the following Board of Studies' members

Name	Designation	University/Institute	Signature	Date
Dr. Dilip Dey	Professor	Haldia Institute of Technology		21-12-2021
Dr. Arabinda Das	Professor	Jadavpur University		21-12-2021
Dr. Jitendranath Bera	Professor	Calcutta University		21-12-2021
Dr. Gautam Sarkar	Professor	Jadavpur University		21-12-2021
Dr. Kaushik Das Sharma	Professor	Calcutta University		21-12-2021
Dr. Chiranjib Koley	Professor	NIT Durgapur		21-12-2021
Mr. Jaijyoti Dhar	General Manager (Electrical)	HPL		21-12-2021
Mr. Subhashish Sarkar	Assistant Professor	Jalpaiguri Govt Engineering College		21-12-2021
Dr. Palash Paul	Professor	Haldia Institute of Technology		21-12-2021
Dr. Santigopal Sir	Associate Professor	Haldia Institute of Technology		21-12-2021
Dr. Parthasarathi Das	Associate Professor	Haldia Institute of Technology		21-12-2021
Dr. Pratyay Konar	Associate Professor	Haldia Institute of Technology		21-12-2021
Mr. Goutam Das	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Sandip Kumar Ojha	Assistant Professor	Haldia Institute of Technology		21-12-2021
Ms. Piya Roy	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Sourav Kumar Das	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Ayandeep Ganguly	Assistant Professor	Haldia Institute of Technology		21-12-2021
Ms. Alpana Barman	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Nayan Manna	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Saubhik Maulik	Assistant Professor	Haldia Institute of Technology	S. Maulik	21-12-2021
Mr. Shouvik Mondal	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Souvik Dutta	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Asit Kumar Mondal	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Debashsish Maji	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Banshidhari Samanta	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Vikash Ranjan	Assistant Professor	Haldia Institute of Technology		21-12-2021
Mr. Sushovan Pramanik	Assistant Professor	Haldia Institute of Technology		21-12-2021