DEPARTMENT
OF
ELECTRICAL & ELECTRONICS ENGINEERING

SCHEME & SYLLABUS
BACHELOR OF TECHNOLOGY
[2024-25]

Date of Revision: May-2024

Effective from 1st semester onwards for 2024 admitted batch and 3rd semester onwards for 2023 admitted batch

SMIT SIKKIM MANIPAL UNIVERSITY
SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

Sikkim Manipal University

Vision

Global Leadership in Human Development, Excellence in Education and Healthcare

Mission

Develop professionals of excellent technical calibre in the field of Health Sciences, Engineering, Management and Social Sciences with a humane approach capable of shouldering the responsibility of building the nation and be globally competent

Sikkim Manipal Institute of Technology

Vision

To achieve eminence in the field of quality technological education and research

Mission

To develop SMIT into an Institution of Excellence capable of producing competent techno-managers who can contribute effectively to the advancement of the society

Electrical & Electronics Engineering Department

Vision

To produce technically efficient engineering graduates with human values and professional ethics capable of performing in rapidly changing fields of electrical and electronics engineering by providing outcome based education and research

Mission

- To develop Electrical and Electronics Engineering Department into a department of excellence, capable of producing competent Electrical and Electronics Engineers who can contribute to the advancement of the society.
- The department is dedicated to endow students with the knowledge, technical skills, and values that prepare them to excel as engineers and leaders in their profession.
- The department is also committed to induce spark in students for life-long learning and to become good citizens.

PROGRAM OUTCOMES

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

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.

PO 11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12 **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1 Solve and analyse electrical circuits, network systems and signal level electronic circuits. Design and interface a microprocessor/microcontroller/embedded system, programming, measuring and sensing equipment.

PSO2 Ability to operate, program and simulate, calibrate and verify the prototypes of various electrical machines, measurement equipment, control system, signal level electronic circuits, power electronics converters, power system equipment, microprocessor and microcontroller in the laboratory.

FIRST YEAR B. TECH CURRICULUM 2024 Onwards (Common to all branches)

(Applicable to students admitted during 2024 and later)

Semester	GROUP A (FIRST SEMESTER) **PHYSICS GROUP**						GROUP B (FIRST SEMESTER **CHEMISTRY GROUP**					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
I		Engineering Mathematics–I	3	1	0	4		Engineering Mathematics–I	3	1	0	4
		Elements of Civil Engineering	3	0	0	3		Element of Mechanical Engineering	3	0	0	3
		Engineering Physics	3	1	0	4		Engineering Chemistry	3	1	0	4
		Basic Electronics	3	0	0	3		Element of Electrical Engineering	3	0	0	3
		Communication Skills	2	0	0	2		Computer Programming in C	3	1	0	4
		Engineering Graphics	1	0	2	2		Environmental Science	1	0	0	1
		Constitution of India	1	0	0	1						
		Workshop Practice	0	0	2	1		Computer Programming Lab	0	0	2	1
		Engineering Physics Lab	0	0	2	1		Engineering Chemistry Lab	0	0	2	1
			16	2	6	21			16	3	4	21
	Total Contact Hours (L + T + P)		24				Total Contact Hours (L + T + P)		23			
II	GROUP A (SECOND SEMESTER)						GROUP B (SECOND SEMESTER)					
		Engineering Mathematics–II	3	1	0	4		Engineering Mathematics–II	3	1	0	4
		Element of Mechanical Engineering	3	0	0	3		Elements of Civil Engineering	3	0	0	3
		Engineering Chemistry	3	1	0	4		Engineering Physics	3	1	0	4
		Element of Electrical Engineering	3	0	0	3		Basic Electronics	3	0	0	3
		Computer Programming in C	3	1	0	4		Communication Skills	2	0	0	2
		Environmental Science	1	0	0	1		Engineering Graphics	1	0	2	2
								Constitution of India	1	0	0	1
		Computer Programming Lab	0	0	2	1		Workshop Practice	0	0	2	1
		Engineering Chemistry Lab	0	0	2	1		Engineering Physics Lab	0	0	2	1
			16	3	4	21	** Optional audit course		16	2	6	21
	Total Contact Hours (L + T + P)		23				Total Contact Hours (L + T + P)		24			

Note: UHV–I has been introduced under Mandatory Induction Program.

B Tech in (ELECTRICAL & ELECTRONICS ENGINEERING- 138 Credit)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
II	MA207A1	Engineering Mathematics-III	3	1	0	4	MA208A1	Engineering Mathematics-IV	3	1	0	4
	EE201A1	Circuits & Networks	3	1	0	4	EE206A1	Signals & Systems	3	1	0	4
	EE202A1	Measurement and Instrumentation	3	1	0	4	EE207A1	Electrical Machines-II	3	1	0	4
	EE203A1	Electrical Machines-I	3	1	0	4	EE2XXA3	Program Elective-II*	3	1	0	4
	EE2XXA3	Program Elective-I*	3	1	0	4	EE2XXA2	Open Elective-II/Minor/ NCC*	3	1	0	4
	EE2XXA2	Open Elective-I/ Minor/ NCC*	3	1	0	4	GN201A1	Universal Human Values-II: Understanding Harmony and Ethical Human Conduct	2	1	0	3
	EE201A4	Electric Circuits & PSPICE Lab	0	0	2	1	EE203A4	Electrical Machines Lab	0	0	2	1
	EE202A4	Analog & Digital Electronics Lab	0	0	2	1	EE204A4	Measurement and Instrumentation Lab	0	0	2	1
	EE201A5	Project Based Learning- I	0	0	2	1	EE202A5	Project Based Learning- II	0	0	2	1
			18	6	6	27			17	6	6	26
	Total Contact Hours (L + T + P)		30				Total Contact Hours (L + T + P) + OE		29			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	EE301A1	Power Electronics	3	1	0	4	BA346A1	Industrial Management	2	0	0	2
	EE302A1	Linear Control Systems	3	1	0	4	EE305A1	Power System-II	3	1	0	4
	EE303A1	Power System-I	3	1	0	4	EE306A1	Advanced Control Theory	3	1	0	4
	EE304A1	Digital System Design	3	1	0	4	EE3XXA3	Program Elective-IV*	3	1	0	4
	EE3XXA3	Program Elective-III*	2	1	0	3	EE3XXA3	Program Elective-V*	3	1	0	4
	EE3XXA2	Open Elective-III/Minor/NCC*	3	1	0	4	EE3XXA2	Open Elective-IV/Minor*	3	1	0	4
	EE301A4	Advance programming Lab	0	0	2	1	EE303A4	Power Electronics and Drives Lab	0	0	2	1
	EE302A4	Control Lab	0	0	2	1	EE304A4	Power System Lab	0	0	2	1
	EE301A5	Project Based Learning- III	0	0	2	1	EE302A5	Mini Project	0	0	2	1
	EE301A9	Industrial Training-I #	0	0	2	1	GN302A1	Quantitative Aptitude and Logical Reasoning-II	1	0	0	1
	GN301A1	Quantitative Aptitude and Logical Reasoning-I	1	0	0	1	EE309A2	Basics of Java (MAC)	2	0	0	0
	EE308A2	Data Structures and Algorithms (MAC)	2	0	0	0						
	MAC: Mandatory audit course		20	6	8	28	MAC: Mandatory audit course		20	5	6	26
	Total Contact Hours (L + T + P)		34				Total Contact Hours (L + T + P)		31			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	EE4XXA2	Open Elective - V/Minor*	3	1	0	4	EE4XXA2	Open Elective - VI/Minor*	3	1	0	4
	EE4XXAX	Choice Based Elective*	3	0	0	3	EE402A6	Major Project – Phase II	0	0	18	9
	EE401A6	Major Project – Phase I	0	0	20	10						
	EE401A9	Industrial Training-II #	0	0	2	1						
			6	1	22	18			3	1	18	13
	Total Contact Hours (L + T + P)		29				Total Contact Hours (L + T + P)		22			

1. *** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**
2. **# Industrial Trainings will be conducted during the summer vacations after IV and VI Semester and evaluated in V and VII Semester respectively.**
3. **A two days' workshop to be conducted department wise in the sixth semester on "Professional Communication and Technical Writing".**

PROGRAM ELECTIVE-I							PROGRAM ELECTIVE-II						
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**		**Subject Code**	**Subject Name**	**L**	**T**	**P**	**C**
EE201A3	Electromagnetic Theory	3	1	0	4		EE204A3	Data Base Management Systems	3	1	0	4
EE202A3	Fundamentals of Nano Electronics	3	1	0	4		EE205A3	Process Control and Instrumentation	3	1	0	4
EE203A3	Analog and Digital Electronics	3	1	0	4		EE206A3	GTD of Electrical Power	3	1	0	4
PROGRAM ELECTIVE-III							**PROGRAM ELECTIVE-IV**						
EE301A3	Latest Trends in Electrical and Electronics Engineering	2	1	0	3		EE304A3	Electrical Drives	3	1	0	4
EE302A3	EHV AC & DC Transmission	2	1	0	3		EE305A3	Electrical Machine Design	3	1	0	4
EE303A3	Embedded Systems	2	1	0	3		EE306A3	Flexible AC Transmission Systems	3	1	0	4
PROGRAM ELECTIVE-V												
EE307A3	High Voltage Engineering	3	1	0	4							
EE308A3	Digital Signal Processing	3	1	0	4							
EE309A3	Modern Power Converters	3	1	0	4							

OPEN ELECTIVE-I/ Specialization							OPEN ELECTIVE-II/ Specialization					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**		**Subject Code**	**Subject Name**	**L**	**T**	**P**	**C**
EE201A2	Analog Systems Design	3	1	0	4		EE205A2	Principles of Communication	3	1	0	4
EE202A2	Data Communication & Computer Networks	3	1	0	4		EE206A2	Software Engineering	3	1	0	4
EE203A2 / EE201A8	Introduction to Hybrid and Electric Vehicles	3	1	0	4		EE207A2	Fuzzy Logic and Evolutionary Algorithms	3	1	0	4
EE204A2 / EE202A8	Computational Intelligence for Power Applications	3	1	0	4		EE208A2 / EE203A8	Sustainable and Renewable Energy Technology	3	1	0	4
EE204A8	Foundations of EV & Hybrid Vehicles ##	3	1	0	4		EE205A8	EV Battery Technology and Powertrain Development ##	3	1	0	4
OPEN ELECTIVE-III/ Specialization							**OPEN ELECTIVE-IV/ Specialization**					
EE301A2	Renewable Energy Systems	3	1	0	4		EE305A2	Advanced Methods in Control Theory	3	1	0	4
EE302A2	Wave Guides & Antenna	3	1	0	4		EE306A2	Machine Learning	3	1	0	4
EE303A2	VLSI Design	3	1	0	4		EE307A2	Digital Image Processing	3	1	0	4
EE304A2 / EE301A8	Energy Storage Technology	3	1	0	4		EE310A2 / EE302A8	Foundations of Optimization	3	1	0	4
EE303A8	EV Power Electronics & Embedded Systems ##	3	1	0	4		EE304A8	EV Charging Infrastructure, Vehicle Testing & Homologation ##	3	1	0	4
OPEN ELECTIVE-V/ Specialization							**OPEN ELECTIVE-VI/ Specialization**					
EE401A2 / EE401A8	Basics of Data Science with Python Programming	3	1	0	4		EE404A2 / EE403A8	Advance Power Converters	3	1	0	4
EE402A2	Bio Medical Instrumentation	3	1	0	4		EE405A2 / EE404A8	Power Electronics for Renewable Energy Technologies	3	1	0	4
EE403A2 / EE402A8	Smart Grid	3	1	0	4		EE406A8	EV PCB Design & Data Analytics ##	3	1	0	4
EE405A8	EV Vehicle Design & Analysis ##	3	1	0	4							

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

For reference: Based on the particular choice of students, he/she may be specialized with any one of the Specialization (Total Credit: 24)												
Specialization-I Subjects [Electric-Drive Vehicle Engineering]/							**Specialization-II Subjects [Power and Energy Systems]**					
EE201A8	Introduction to Hybrid and Electric Vehicles	3	1	0	4		EE202A8	Computational Intelligence for Power Applications	3	1	0	4
EE203A8	Sustainable and Renewable Energy Technology	3	1	0	4		EE203A8	Sustainable and Renewable Energy Technology	3	1	0	4
EE301A8	Energy Storage Technology	3	1	0	4		EE301A8	Energy Storage Technology	3	1	0	4
EE302A8	Foundations of Optimization	3	1	0	4		EE302A8	Foundations of Optimization	3	1	0	4
EE401A8	Basics of Data Science with Python Programming	3	1	0	4		EE402A8	Smart Grid	3	1	0	4
EE403A8	Advance Power Converters	3	1	0	4		EE404A8	Power Electronics for Renewable Energy Technologies	3	1	0	4
Specialization-III												
Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech												
EE204A8	Foundations of EV & Hybrid Vehicles	3	1	0	4							
EE205A8	EV Battery Technology and Powertrain Development	3	1	0	4							
EE303A8	EV Power Electronics & Embedded Systems	3	1	0	4							
EE304A8	EV Charging Infrastructure, Vehicle Testing & Homologation	3	1	0	4							
EE405A8	EV Vehicle Design & Analysis	3	1	0	4							
EE406A8	EV PCB Design & Data Analytics	3	1	0	4							

TABLE OF CONTENT

ELECTRICAL & ELECTRONICS ENGINEERING

(FIRST YEAR SUBJECT)

I/II SEMESTER B.TECH. (COMMON TO ALL)

EE101A1 **Credit: 3 (L-3,T-0,P-0)**

ELEMENTS OF ELECTRICAL ENGINEERING

Question to be set: 05 (All Compulsory)

Course Objectives:

- To impart the basic knowledge about the Electric and Magnetic circuits.
- To inculcate the understanding about the AC fundamentals.
- To understand the working of various Electrical Machines.
- To know about single line diagram of power system.

Pre-requisites: Basic knowledge of physics and solving skills.

Course Outcome (CO)

CO1 To implement mesh and nodal analysis to analyse dc circuits

CO2 To determine the analogy between electrical and magnetic circuits and thus analyse magnetic circuit

CO3 Identify, characterize and thus analyse single and three phase ac circuit

CO4 To demonstrate the operation and application of transformer and induction motor

CO5 To describe the operation and layout of a power system network

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 DC Circuits	In class	Review of Linear, Lumped, Finite, Passive, Bilateral Circuit Elements, Voltage sources, Current sources, Mesh Current and Node Voltage analysis of DC Circuits	10	1	1,2	1
	Assignment Topic					
Module 2 Magnetic Circuits	In class	MMF, Magnetic flux, Reluctance, Flux density, Analogy with electric circuits, Analysis of magnetic circuits.	4	2	1,2	1
	Assignment Topic					
Module 3 AC Circuits	In class	Single phase AC Circuit Representation of sinusoidal voltages and currents, rms value and average value, joperator, Phasors, Voltages and Currents relationship and instantaneous and average power in a pure resistor, pure inductor and pure capacitor, Impedance, Admittance, Analysis of circuits, Complex power, active and reactive powers, Power Triangle, Power factor Three phase AC Circuit	12	3	1,2,3	1

		Symmetrical sinusoidal supply systems, voltage, current and power relationship in 3-phase balanced star and delta connected loads, Analysis of three phase balanced star and delta connected loads.				
	Assignment Topic					
Module 4 Transformers And Three Phase Induction Motors	In class	Transformers Construction, working principle, Emf equation, Transformer on no-load, Phasor diagrams on no-load and full-load Three Phase Induction Motors Principle of operation, slip, rotor induced emf, rotor frequency	8	4	1,2,3	1
	Assignment Topic					
Module 5 Power System	In class	Scheme of Power System from generation, transmission & distribution.	2	5	3	1
	Assignment Topic					

Textbooks:

1. Basic Electrical Engineering: M S Naidu & S Kamakshiah: TataMcGraw Hill Publications
2. Basic Electrical Engineering: T K Nagasarkar and M S Sukhija: Oxford University Press
3. Electrical & Electronics Technolgy: Hughes: Pearson Publications

References:

1. Theory and Problems of Basic Electrical Engineering: D P Kothari & I J Nagrath: Prentice Hall Publication
2. Principles of Electrical Engineering: V K Mehta: S Chand Publications

SCHEME

Year	THIRD SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**
II	MA207A1	Engineering Mathematics-III	3	1	0	4
	EE201A1	Circuits & Networks	3	1	0	4
	EE202A1	Measurement and Instrumentation	3	1	0	4
	EE203A1	Electrical Machines-I	3	1	0	4
	EE2XXA3	Program Elective-I *	3	1	0	4
	EE2XXA2	Open Elective-I/Minor/ NCC *	3	1	0	4
	EE201A4	Electric Circuits & PSPICE Lab	0	0	2	1
	EE202A4	Analog & Digital Electronics Lab	0	0	2	1
	EE201A5	Project Based Learning- I	0	0	2	1
			18	6	6	27
	Total Contact Hours (L + T + P)		30			

PROGRAM ELECTIVE-I					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE201A3	Electromagnetic Theory	3	1	0	4
EE202A3	Fundamentals of Nano Electronics	3	1	0	4
EE203A3	Analog and Digital Electronics	3	1	0	4

OPEN ELECTIVE-I/ Specialization					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE201A2	Analog Systems Design	3	1	0	4
EE202A2	Data Communication & Computer Networks	3	1	0	4
EE203A2 / EE201A8	Introduction to Hybrid and Electric Vehicles ***	3	1	0	4
EE204A2 / EE202A8	Computational Intelligence for Power Applications***	3	1	0	4
EE204A8	Foundations of EV & Hybrid Vehicles ***	3	1	0	4

*** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**

***** Specialization syllabus attached at the end of the document.**

III SEMESTER B.TECH. (E&E)

MA207A1 **Credit: 4 (L-3,T-1,P-0)**

ENGINEERING MATHEMATICS-III

Question to be set: 05 (All Compulsory)

Course Objectives:

- The objective of teaching this paper is to develop the full Fourier series of a real-valued 2L periodic function. To understand how the Fourier series is extended to aperiodic signals in the form of Fourier transform. Fourier transform is also used to solve differential equations.
- Introduce students to partial differential equations. To make students capable of solving linear Partial Differential with different techniques like separation of variables direct integration etc.
- To make students understand definition of gradient, Divergent, Curl and illustrate geometric meanings in engineering problems. To solve vector integration and its applications.
- Many of engineering problems are governed by nonlinear differential equations, algebraic equations with involvement of complex integrations, to get analytic solutions for such problems is difficult, in such cases numerical methods are helpful

Pre-requisites: Engineering Mathematics-I, Engineering Mathematics-II

Course Outcome (CO)

CO1	Fourier series, Fourier integral and Fourier transforms used in engineering applications.
CO2	Apply a range of techniques to find solutions of standard Partial Differential Equations (PDE), Demonstrate capacity to model physical phenomena using PDE's (in particular Laplace's equation).
CO3	Definition of gradient, Divergent, Curl and illustrate geometric meanings in engineering problems. The concept of a vector integration and its applications.
CO4	Interpolation and its application, Numerical differentiation.
CO5	Numerical Integration, Numerical solution of system of linear equations, Computation of largest eigenvalue by power method.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 Fourier analysis	In class	Periodic functions, Trigonometric Series, Fourier series, Fourier series of odd and even functions, functions with arbitrary period, half range expansion, Fourier integrals, Fourier transforms, Fourier sine and cosine transforms, Convolution theorem(statement only).	10	1	1,3	5
	**Assignment Topic	Fourier Series, Fourier Transformation		1	1,3	5
Module 2 Partial differential equations	In class	Definition, degree, order of a PDE. Formation of PDE. Linear and nonlinear PDE. Solution of first order linear PDE, Solution of higher order PDE by direct integration. Method of separation of variables. Solution of two dimensional Laplace's equation.	8	2	1,3	5
	**Assignment Topic	Method of separation of variables, Solution of Laplace equation.		2	1,3	5
Module 3 Vector calculus	In class	Vector: Differentiation, gradient, divergence and curl, their physical meaning and identities. Line, surface and volume integrals and problems-	8	3	1,3	5

		Statement on Green's theorem, divergence and Stoke's theorems and their applications				
	**Assignment Topic	Line Integrals, Surface Integrals, Volume Integrals.		3	1,3	5
Module 4 Numerical Methods I	In class	Interpolation and application: finite difference, central and divided differences, Newton - Gregory and Lagrange's interpolation formulae. Inverse interpolation. Numerical differentiation.	5	4	1,3	5
	**Assignment Topic	Interpolation problem, Numerical Differentiation.		4	1,3	5
Module 5 Numerical Methods I	In class	Numerical integration: Trapezoidal rule, Simpson's one third and three eight rule Solution of systems of linear equation: Jacobi, Gauss- Seidal methods. Solution of tridiagonal systems. Eigenvalues and eigenvectors of matrices and elementary properties, computation of largest eigenvalue by power method.	5	5	1,3	5
	**Assignment Topic	Numerical Integration, Power method for finding highest Eigen value.	5	5	1,3	5

Textbooks:

1. C. E. Weatherburn : Vector Analysis, G Bells & Sons
2. Erwin Kreyszig : Advanced Engineering Mathematics, Wiley
3. S. S. Sastry: Introductory Method Numerical Analysis. PHI.
4. I. Sneddon, Elements of Partial Differential Equations, Dover Publications INC

References:

1. M. K. Jain and S.R.K. Iyengar and R. K. Jain: Numerical methods for scientific and engineering computations. New Age International.
2. Murray R. Spigel : Vector Analysis, Schaum’s Outline Series.

III SEMESTER B.TECH. (E&E)

EE201A1 **Credit: 4 (L-3,T-1,P-0)**

CIRCUITS AND NETWORKS

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this subject is to impart the basic knowledge about different Network theorems and Resonance of circuit. Also, to understand the time domain analysis of system and to know about Network Topology and synthesis of passive networks.

Pre-requisites: Basic Electrical, Engineering Physics, Engineering Mathematics.

Course Outcomes (CO):
CO1: Apply laws of electrical theorems to solve an electrical circuit.
CO2: Understand the phenomena of Resonance and determine circuit parameters.
CO3: Apply time domain analysis to first order circuits and understand frequency domain analysis of electric circuits.
CO4: Conduct Graph Theory analysis to form mathematical equations of Electric Networks.
CO5: Develop various Network parameters of 2-port networks and synthesize LC networks by Foster methods.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module:1	In class	**Network theorems:** Linearity and superposition Theorem, Thevenin's Theorem, Maximum power transfer theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem. (A.C. & D.C.)	10	1	1,2	1
	**Assignment					
Module: 2	In class	**Resonance**-series and parallel, Half power frequencies, quality factor, Band width, Impedance, Admittance and current locus for series and parallel circuits, current at resonance from locus diagram	8	2	1,2	1
	**Assignment					
Module: 3	In class	**Time Domain Analysis Of First And Second Order Circuits:** Introduction, source free RC and RL circuits, Response of the first order circuit for different type of excitation like step, impulse, sinusoidal and exponential, Time constant, Source free RLC Series and Parallel circuit, Impulse and Step response of Series and Parallel RLC circuits, Setting time, rise time, Maximum overshoot. **Network Functions:** Driving point and Transfer function, Poles and Zeroes and its significance.	10	3	1,2	1

	**Assignment					
Module: 4	In class	**Network Topology** Graph of a network, Concept of tree and cotree, incidence matrix, tie set and cut set, Formulation of equilibrium equation in matrix form, Principle of duality, Tellegen's Theorem.	8	4	1,2	1
	**Assignment					
Module: 5	In class	**Synthesis:** Hurwitz polynomials, Concept of positive real functions and testing procedures for realness. Synthesis of one port LC, RL, RC Networks by Foster and cauer methods. Zeroes of transmission,	8	5	1,2	1
	**Assignment					

Text Books:

1. Circuit Theory by A Chakraborti, Dhanpat Rai Publications
2. Basic Circuit Theory by Charles A. Deosar& Ernest S.Kuh (McGraw hill international edition)
3. Network Theory and Filter Design by V.K Aatre (new age publication)
4. Introduction to Modern Network Synthesis by Van Valkenburg (PHI publication)
5. Circuit Analysis by T. S.K. V. Iyer (TMH publication)

Reference Books:

1. Network Analyses by Van Valkenburg (PHI Publication)
2. Network Analysis and Synthesis by F.F.Kuo John Wiley &sons
3. Fundamentals of Electric Circuits, Charles K. Alexander & Matthew N.O. Sadiku

III SEMESTER B.TECH. (E&E)

EE202A1 **Credit:4 (L-3, T-1, P-0)**

MEASUREMENT AND INSTRUMENTATION

Questions to be set: 05 (All Compulsory)

Course Objectives:

- Introduction to units of measurements and basic operating principles of electromechanical indicating and digital instruments for measurement of voltage, current, power and energy.
- Analysis of measurement of resistance, inductance and capacitance through various bridge circuits.
- To develop transfer function and controller design.
- Familiarization with root locus techniques and frequency domain analysis for stability and performance determination

Pre-requisites: Knowledge of basic circuit theory.

Course Outcomes (CO):

CO1 Analyse operating principles of electromechanical indicating and digital instruments for measurement of voltage, current, power and energy.

CO2 Analyse the measurement of resistance, inductance and capacitance through various bridge circuits and able to identify the appropriate bridge circuit for measurement of resistance, inductance and capacitance.

CO3 Design and analysis of signal generators and instrument transformers.

CO4 Identify and summarize the important feature of electrical transducers.

CO5 Test and determine the specification of a given signal through Cathode Ray Oscilloscope (CRO) and wave analyzers.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Electromechanical indicating and Digital instruments	In class	The fundamental units of SI, derived units, conversion factors. Errors- definition; types of errors in measurement. The D'Arsonval Galvanometer, principle of operation and use as an ammeter and voltmeter. Basic idea about instruments with non-linear response- moving iron type, electrodynamometer, multimeter and energy meter; rectifier-type instrument. Single-phase and three-phase energy meters. Digital voltmeters and multimeters.	8	1		
	**Assignment Topics					
Module 2: Measurement of resistance, inductance and capacitance	In class	Classification of resistance; Wheatstone bridge (W.B.), limitations of W.B., Kelvin's double bridge. Concept of earth resistance and its measurement; Megger. AC Bridges- Maxwell's bridge, Maxwell-Wein bridge,	8	2		

		Anderson's bridge, Schering bridge, Desauty bridge.				
	****Assignment Topics**					
Module 3: Signal generator & Instrument transformer.	In class	Fixed and variable, AF oscillators, standard and AF sine and square wave signal generators, function Generators, square pulse, random noise and sweep. Current transformer (CT) and potential transformer (PT); construction and operation for metering and protection applications; Silsbee's method.	8	3		
	**Assignment Topics					
Module 4: Transducers	In class	Introduction and classification. Strain gauges, force-summing members such as diaphragms, bourdon tubes and piezo-electric devices. Hall-Effect transducers. Temperature sensors- resistance-type temperature sensors esp. platinum resistance thermometer, thermistors and thermocouple- properties, materials used for construction, reference junction compensation of thermocouples. Current, voltage, and torque transducers.	8	4		
	****Assignment Topics**					
Module 5: Cathode Ray Tube (CRT) and Wave Analyzer	In class	Construction, working and general applications. Measurement of voltage, current, phase and frequency (using Lissajous patterns) on a CRO. Introduction and qualitative treatment of frequency selective wave analyzer and heterodyne wave analyzer; discussions on basic spectrum analyzer. Data acquisition system, including the concept of virtual instrumentation.	8	5		
	****Assignment Topics**					

Recommended Books:

1. Cooper W. O. and Helfrick A. D. - Modern Electronic Instrumentation and Measurement Techniques.
2. A. K. Sawhney - A course in electrical and electronic Measurements and Instrumentation.
3. E.W. Golding & F.C. Widdis - Electrical Measurements and Measuring Instruments.

III SEMESTER B.TECH. (E&E)

EE203A1 **Credit: 4 (L-3, T-1, P-0)**

ELECTRICAL MACHINES – I

Questions to be set: 05 (All Compulsory)

Course Objectives: To clearly understand the basic concepts of the electrical machines working in the modern power system such as transformers and d.c. machines. To learn the analytical methods to develop the machine models and to further solve problems associated operation of transformers, motors and generators.

Course Outcome:

On successful completion of this course, students will be able to

- CO1 Describe construction, operation and development of phasor diagram of transformer.
- CO2 Analyze equivalent circuit, losses, efficiency, voltage regulation, and tests on transformer.
- CO3 Evaluate parallel operation of transformers, operation of auto transformer.
- CO4 Describe construction, operation, and characteristics of all types of dc machines (both motors and generators).
- CO5 Analyze the speed control, losses, efficiency, and tests on dc machines.

Pre-requisites: None

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: Transformer Fundamentals	In class	Transformers: Review of Construction, ratings & specification of transformer, Principle of operation of single phase transformer	4	CO 1	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 2: Phasor diagram, equivalent circuit, tests, voltage regulation, losses and efficiency.	In class	Phasor diagram (no-load and on-load). Development of equivalent circuit, O.C and S.C tests, Voltage regulation, losses and efficiency, All-day efficiency	7	CO 1, CO 2	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 3: Tests, Parallel operation, and Autotransformers.	In class	Polarity test, Sumpner's test. Parallel operation of single phase and three phase	7	CO 2, CO 3	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2

		transformers, Autotransformers.				
	** Assignment Topics					
Module 4: D.C. Machines fundamentals, excitation, and characteristics	In class	DC Generators: Construction, principle of operation, Methods of excitation, armature reaction, commutation, characteristics of DC generators-OCC and external characteristics. DC Motors: Principle of operation, characteristics of motors, different types of D.C. motor (shunt & series & compound).	9	CO 4	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 5: Speed control, starters, losses and efficiency, tests.	In class	Field and armature methods of speed control, principle of DC motor starting, 3 point starters. Losses and Efficiency of DC machines, Swinburne's test, Hopkinson's test.	9	CO 5	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					

Text Books:

1. P.S. Bhimbra – Electrical Machinery (Ed. 4) – Khanna Pub, 1986

Reference Books:

1. Clayton and Hankock – Performance and Design of DC Machines – Oxford IBH, 1994.
2. Nagrath and Kothari – Electrical Machines TMH, 1993.
3. M.G. Say – AC. Machines (Ed.5) – Pitman, 1993.
4. P.K. Mukherjee & S. Chakravorti – Electrical Machines (Ed.2) – Dhanpat Rai, 1993

III SEMESTER B.TECH. (E&E)

EE201A4 **Credit: 1 (L-0, T-0, P-2)**

ELECTRIC CIRCUITS & PSPICE LAB

Objective: To introduce the students to the basic electrical equipments in the lab. To teach the students to measure resistance, inductance, capacitance, voltage and current. To enable the students to connect various types of electrical circuit and analyze various theorems and laws. To verify various theorems using softwares like Pspice and MATLAB. To bridge the gap between theoretical calculations and practical implementation.

Course Outcome: Verification of various theorems in hardware circuit as well as in software.

Pre-requisites: Basic knowledge about various theorem and laws based on electrical circuits

1. To verify Norton's theorem both through simulation in Pspice environment and hardware setup .
2. To verify Thevenin's theorem both through simulation in Pspice environment and hardware setup.
3. To verify Superposition theorem both through simulation in Pspice environment and hardware setup.
4. To verify Maximum power theorem both through simulation in Pspice environment and hardware setup
5. To verify Reciprocity theorem both through simulation in Pspice environment and hardware setup.
6. Series RLC resonance.
7. Parallel RLC resonance.
8. Measurement of 3-Phase power using two watt meter method.
9. Measurement of inductance.

Extra Experiments (beyond course curriculum)

10. Transient response of RL circuit both through simulation in Pspice environment and hardware setup.
11. Transient response of RC circuit both through simulation in Pspice environment and hardware setup.
12. Source free RC circuit both through simulation in Pspice environment and hardware setup.
13. Study of RLC circuit and determination of time constant, damping factor mathematically and graphically for different damping cases.
14. Verification of Superposition theorem in MATLAB platform.
15. Verification of Reciprocity theorem in MATLAB platform.

III SEMESTER B.TECH. (E & E)

EE202A4 **Credit: 1 (L-0, T-0, P-2)**

ANALOG & DIGITAL ELECTRONICS LAB

Objective: To provide facilities in performing experiments related to various types of electronic devices and analyzing it.

Course Outcome: Such hand on experience provides students with critical practical aspects of analog and digital electronic design

Pre-requisite: Theoretical concept of analog and digital system.

FIRST CYCLE: ANALOG SYSTEM DESIGN

1. Design of adder circuit using OP-AMP.
2. OP-AMP as an integrator & differentiator.
3. Design a current to voltage and voltage to current converter using OP-AMP.
4. Design a Comparator circuit using OP-AMP-741 to compare between two Input.
5. Design a triangular wave generator using OP-AMP.
6. Design a Monostable and AstableMultivibrator using 555 Timer.
7. Design of a 1^{st} order and 2^{nd} order Low-Pass filter using OP-AMP with cutoff frequency at 1 KHz & pass band gain 2.

Extra Experiment (beyond course curriculum)

8. Design of a 1^{st} order and 2^{nd} order High-Pass filter using OP-AMP with cutoff frequency at 1 KHz & pass band gain 1.58.

SECOND CYCLE: DIGITAL SYSTEM DESIGN

1. To implement and verify BCD to XS-3 code converter.
2. Implementation of R-S, J-K, D Flip-Flop.
3. To implement a 3 bit MOD – 6 Synchronous Counter.
4. Design a 3 bit Ring Counter & Twisted Ring Counter by the help of Synchronous circuit Design.
5. To implement a 3 bit MOD – 6 Asynchronous Counter

Extra Experiment (beyond course curriculum)

6. Design a 3 bit UP- DOWN counter with the help controlling Signal X. If X=1 It will count upward direction and if X =0 count downward direction.

III SEMESTER B.TECH. (E & E)

EE201A5 **Credit: 1 (L-0, T-0, P-2)**

PROJECT BASED LEARNING-I

Objective: To motivate the students in research/paper publication/practical application which will help them in understanding/analysis/formulating the problem related to the advanced and relevant areas of engineering.

Course Outcome: On successful completion of course students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.

Pre-requisite: None.

Project Based Learning projects should be done by the students starting from 1st semester for which a teacher is assigned to the student(s) under whom he/she/they will work. **Project Based Learning-I** is the part of the curriculum in Semester-III with credit 1.0. Minimum contact hour per week is 2 hrs.

SCHEME

Year	FOURTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C
II	MA208A1	Engineering Mathematics-IV	3	1	0	4
	EE206A1	Signals & Systems	3	1	0	4
	EE207A1	Electrical Machines-II	3	1	0	4
	EE2XXA3	Program Elective-II *	3	1	0	4
	EE2XXA2	Open Elective-II/Minor/ NCC *	3	1	0	4
	GN201A1	Universal Human Values-II: Understanding Harmony and Ethical Human Conduct	2	1	0	3
	EE203A4	Electrical Machines Lab	0	0	2	1
	EE204A4	Measurement and Instrumentation Lab	0	0	2	1
	EE202A5	Project Based Learning- II	0	0	2	1
			17	6	6	26
	Total Contact Hours (L + T + P) + OE		29			

PROGRAM ELECTIVE-II					
Subject Code	Subject Name	L	T	P	C
EE204A3	Data Base Management Systems	3	1	0	4
EE205A3	Process Control and Instrumentation	3	1	0	4
EE206A3	GTD of Electrical Power	3	1	0	4

OPEN ELECTIVE-II/ Specialization					
Subject Code	Subject Name	L	T	P	C
EE205A2	Principles of Communication	3	1	0	4
EE206A2	Software Engineering	3	1	0	4
EE207A2	Fuzzy Logic and Evolutionary Algorithms	3	1	0	4
EE208A2 / EE203A8	Sustainable and Renewable Energy Technology ***	3	1	0	4
EE205A8	EV Battery Technology and Powertrain Development ***	3	1	0	4

*** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**

***** Specialization syllabus attached at the end of the document.**

IV SEMESTER B.TECH. (E&E)

MA208A1 **Credit: 4 (L-3,T-1,P-0)**

ENGINEERING MATHEMATICS-IV

Question to be set: 05 (All Compulsory)

Course Objectives:

- The objective of teaching probability is to provide some basic idea on Probability and its applications in the field of Science and Engineering. It has lot of applications in Digital Communications & Modeling of physical problems.
- Numerical analysis has numerous applications in all fields of science and engineering, and essentially any type of work that requires calculations to give very precise solutions.
- Complex numbers are applied to study control theory, signal analysis, electromagnetism and electrical engineering etc.
- The Z transform is used in many applications of mathematics and in signal processing.

Pre-requisites: MA10101A,MA10102A,MA10111A

Course Outcome (CO)

CO1	Basic concepts of probability and its applications in the field of engineering.
CO2	Numerical analysis for Engineering Application problems.
CO3	Basic concepts of complex numbers and complex variables functions, Analytic function.
CO4	Complex integration, Laurent's series and applications.
CO5	Z-transforms and its application in solving boundary value problems.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 Probability Theory	In class	Finite sample space, conditional probability and independence, Baye's theorem, one dimensional random variable, mean, variance. Distributions : Binomial, Poisson, Uniform, Normal and their applications.	10	1	1,3	5
	**Assignment Topic	Bays Theorem, Normal Distribution.		1	1,3	5
Module 2 Numerical Methods II	In class	Numerical solution of algebraic and transcendental equations using Newton Rapson's method, Solution of nonlinear equation by Newton Rapson's method, Numerical solution of initial value problems in ordinary differential equations by Taylor series method, RungeKutta 4Th order Method.	8	2	1,3	5
	**Assignment Topic	Taylor's series method, RK-4 method.		2	1,3	5
Module 3 Complex Analysis	In class	Introduction –functions, analyticity -Cauchy Riemann equations and properties of ana1ytic functions.	4	3	1,3	5
	**Assignment Topic	Analytic functions.		3	1,3	5
Module 4 Complex Analysis	In class	Line integrals in complex plane and basic properties of Cauchy's integral theorem and Cauchy's integral formula - derivatives of analytic functions. Taylor, Maclaurin and Laurent's series, residue theorem and its applications.	8	4	1,3	5

	**Assignment Topic	Laurent series and Residue theorem.		4	1,3	5
Module 5 Application of Fourier and Z Transform	In class	Parseval's identity of Fourier transforms, Solution of boundary value problems using Fourier transforms, Z transforms, Solution of difference equation using Z transforms.	6	5	1,3	5
	**Assignment Topic	Solution of difference equation.		5	1,3	5

Textbooks:

1. P.L. Meyer : Introduction to Probability and Statistical Applications.
2. S.S. Sastry : Introductory methods of numerical analysis
3. Erwin Kreyszig : Advanced Engineering Mathematics
4. R. V. Churchill and J. W. Brown : Complex variables and applications

References:

1. Hogg and Craig : Introduction to Mathematical Statistics.
2. S.M. Ross: introduction to probability and statistics for engineers and scientists.
3. K.S. Trivedy : Introduction to probability and statistics and queuing theory.
4. M.K. Jain and S.R.K. Iyengar and R.K. Jain : Numerical methods for scientific and engineering computations.
5. Murray R. Spigel : Complex variable, Schaum Outline Series.

IV SEMESTER B.TECH. (E&E)

EE206A1 **Credit:4 (L-3, T-1, P-0)**

SIGNALS AND SYSTEMS

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To introduce different types of signals, their behavior and significance.
- To understand various classifications of systems and their characteristics.
- Understand the representation of signals and systems in time and frequency domain.
- To introduce the concept of transforms and their properties.
- To understand analog filters, their representation and characteristics.

Pre-requisites: Basics mathematics of differentiation and integration.

Course Outcomes (CO):

CO1	Develop a fundamental understanding of signals and systems and their characteristics.
CO2	Apply Laplace transforms for signal analysis.
CO3	Apply mathematical modelling for Time domain representation and analysis of signals and systems.
CO4	Apply mathematical modelling for Frequency domain representation and analysis of signals and systems.
CO5	Develop basic understanding of filters, their characteristics and design techniques for analog filters.

**not more than 20% of total topics to be allotted for assignment

Module	**Topics To be Covered**	**Topics**	**Hrs**	**CO**	**PO**	**PSO**
Module 1: Introduction to signals and systems.	In class	**Sub topic 1:** Definition of signal, Classification of signals with examples, Elementary signals, Basic operations on signals and related numericals. **Sub topic 2:** Definition of system, Classification of system and their Properties.	9	1	1,2	1
	**Assignment Topics					
Module 2: Laplace Transforms	In class	**Sub topic 1:** Introduction, bilateral and unilateral Laplace transforms and their region of convergence, Inverse Laplace transform, Properties of Laplace transforms. **Sub topic 2:** Numerical on Laplace transforms using properties and formulae. Application in solving circuit problems and differential equation.	9	2	1,2	1
	****Assignment Topics**	Proofs of properties of Laplace transforms and related numericals.				
Module 3: Time-Domain Representations For Linear Time Invariant (LTI) Systems	In class	**Sub topic 1:** Differential and difference equation representations (classical method), related numerical. **Sub topic 2:** Impulse response representations (convolution integration and convolution sum), properties of impulse response representations, block diagram representations.	9	3	1,2	1

	**Assignment Topics					
Module 4: Fourier Representation For Signals	In class	**Sub topic 1:** Introduction, Continuous Time and Discrete Fourier series, **Sub topic 2:** Continuous Time and Discrete Fourier Transforms. **Sub topic 3:** Application of Fourier representations, Frequency response of LTI systems and numerical on it.	10	4	1,2	1
	****Assignment Topics**	Properties and related numerical for continuous and discrete time Fourier series and transforms.				
Module 5: Analog Filter Design	In class	**Sub topic 1:** Introduction, Classification of filters, filter characteristics. **Subtopic 2:** Design of Analog filters.	7	5	1,2	1
	****Assignment Topics**					

RECOMMENDED BOOKS:

1 Signal & System by Haykin Van Veen (John Wiley and Sons)
2 Signal & System by I.J.Nagrath,S.N. Sharan ,R Ranjan (TMH)
3. Signal and System by D .k Cheng
4. Digital Filter Analysis, Design, and Application by Andrews Antononiu (TMH)

IV SEMESTER B.TECH. (E&E)

EE207A1 **Credit: 4 (L-3, T-1, P-0)**

ELECTRICAL MACHINES – II

Questions to be set: 05 (All Compulsory)

Course Objectives: To clearly understand the basic concepts of the electrical machines used in industry and power plants such as induction motors and synchronous machines. To learn the analytical methods to develop the machine models and to further solve problems associated operation of induction motors and synchronous machines.

Course Outcome:

On successful completion of this course, students will be able to

CO1 Describe the construction and operation of three-phase induction motor, single-phase induction motor and induction generator.

CO2 Analyze the equivalent circuit, torque equation, parameter identification tests and starters.

CO3 Describe the construction and operation of synchronous machines.

CO4 Analyze the equivalent circuit, voltage regulation and parallel operation of alternators.

CO5 Illustrate concepts of V-curves, hunting and starting methods of synchronous motor.

Pre-requisites: None

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: Fundamentals of three-phase induction motors	In class	Review of construction and principle of operation of three-phase induction motor	4	CO 1	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 2: Equivalent circuit, Torque equations, and characteristics.	In class	Development of equivalent circuit. Torque equation, Torque-slip characteristics	7	CO 2	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 3: Tests, starters, induction generator, single-phase	In class	No load and blocked rotor tests, Starters, induction generator, Single Phase Induction Motors.	7	CO 2	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2

induction motors.	** Assignment Topics					
Module 4: Synchronous Generators	In class	Constructional features, EMF equation, Armature reaction. Leakage reactance, Synchronous impedance, Equivalent circuit. Phasor diagram, Voltage regulation by EMF, MMF, ZPF, Two reaction field theory and Phasor diagram for salient pole machines and slip test.	10	CO 3, CO 4	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 5: Synchronization and Synchronous motors	In class	Synchronizing power and torque, Parallel operation of two alternators and load sharing, Construction, Principle of operation, V-curves, Hunting. Starting methods.	8	CO 4, CO 5	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					

Text Books:

1. P.S. Bhimbra – Electrical Machinery (Ed. 4) – Khanna Pub, 1986

Reference Books:

1. Langsdorf A. - Theory of AC Machinery- TMH, 1994.

2. Lawrence and Richards- Principles ofAC Machinery (ED. 4.)- MGH. 1953.
3. M.G. Say- AC Machines (ED. 5)- Pitmam, 1983.
4. Nagrath and Kothari-Electrical Machines- TMH, *1093.*
5. P.K. Mukherjee and S. Chakravorti- Electrical Machines (ED. 2)- DhanpatRai. 1993.

IV SEMESTER B.TECH. (E&E)

GN201A1 **Credit: 3 (L-2, T-1, P-0)**

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT

Course Objectives:

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much needed orientational input in value education to the young enquiring minds.

Pre-requisites: None. However, it is desired that students may have gone through UHV-I: Universal Human Values-Introduction

Course Outcome (CO):

1. Students are expected to understand self-exploration and Basic Human Aspirations.
2. To understand harmony in themselves (Human being).
3. To become more aware of their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
4. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1) Holistic vision of life
2) Socially responsible behaviour
3) Environmentally responsible work
4) Ethical human conduct
5) Having Competence and Capabilities for Maintaining Health and Hygiene
6) Appreciation and aspiration for excellence (merit) and gratitude for all

Module 1 –Introduction to Value Education (9 Hrs)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session *PS1* *Sharing about Oneself*
Lecture 3: Self-exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice Session PS*2 Exploring Human Consciousness*
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfil the Basic Human Aspirations
Tutorial 3: Practice Session PS*3 Exploring Natural Acceptance*

Module 2 – Harmony in the Human Being (9 Hrs)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body
Lecture 8: Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session PS*4 Exploring the difference of Needs of Self and Body*
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session PS*5 Exploring Sources of Imagination in the Self*
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS*6 Exploring Harmony of Self with the Body*

Module 3 – Harmony in the Family and Society (9 Hrs)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS*7 Exploring the Feeling of Trust*
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS*8 Exploring the Feeling of Respect*
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS*9 Exploring Systems to fulfil Human Goal*

Module 4 – Harmony in the Nature/Existence (6 Hrs)

Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation, and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS*10 Exploring the Four Orders of Nature*
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS*11 Exploring Co-existence in Existence*

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (9 Hrs)

Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS*12 Exploring Ethical Human Conduct*

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS*13 Exploring Humanistic Models in Education*

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS*14 Exploring Steps of Transition towards Universal Human Order*

Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

PS1Sharing about Oneself

PS2Exploring Human Consciousness

PS3Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being

PS4 Exploring the difference of Needs of Self and Body

PS5 Exploring Sources of Imagination in the Self

PS6Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust PS8 Exploring the Feeling of Respect

PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Text Book

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1

The Teacher's Manual

Teachers' Manual for *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

IV SEMESTER B.TECH. (E & E)

EE203A4 **Credit: 1 (L-0, T-0, P-2)**

ELECTRICAL MACHINES LABORATORY

Objective: To provide facilities in performing experiments related to various types of electrical machines and analyzing it. To introduce the students to single phase and three phase electrical machines & various types drives systems.

Course Outcome: Such hand on experience provides students with critical practical aspects of electrical machines.
Pre-requisite: Theoretical concept of electrical machines.

1. Open circuit & Short Circuit test on a single phase transformer.
2. Sumpner's Test
3. Polarity Test & Parallel Operation of Two Single Phase Transformer.
4. Swinburne's Test
5. Hopkinson's Test (Regenerative Test)
6. Speed Control of DC Shunt Motor
7. Load Test on DC Shunt Generator
8. Load Characteristic of DC Shunt Motor
9. No Load and Blocked Rotor test on a three phase induction motor.
10. Torque Slip Characteristics of Slip Ring Induction Motor by varying rotor resistance.
11. Load Test on three Phase squirrel cage Induction Motor.
12. Measurement of Direct Axis and Quadrature axis reactance of salient pole Synchronous Machine
13. Predetermination of Voltage Regulation of Alternator by EMF and MMF methods.
14. Load Test on three Phase Induction Generator.
15. V curve and Inverted V curve of Synchronous Motor.

IV SEMESTER B.TECH.(E&E)

EE204A4 **Credit: 1 (L-0, T-0, P-2)**

MEASUREMENT AND INSTRUMENTATION LAB

Objective: To provide facilities in performing experiments related to various types of electrical and electronic measurement devices and analyzing it.

Course Outcome: Such hand on experience provides students with critical practical aspects of analog and digital electronic measurement
Pre-requisite: Theoretical concept of measurement and instrumentation.

1. Measurement of inductance by
   (a) Maxwell Inductance Capacitance Bridge and
   (b) Andersons Bridge.
2. Measurement of capacitance by Schering Bridge.
3. (a) Measurement of medium resistance (Wheatstone bridge).
   (b) Measurement of low resistance (Kelvin double bridge).
4. Adjustment and calibration of single phase energy meter.
5. Adjustment and calibration of three phase energy meter.
6. ADC-Measurement of conversion time and quantization error.
7. DAC- Unipolar and bipolar connections, measurement of accuracy.
8. To measure the voltage using Piezo-electric transducer.
9. To measure pressure in terms of voltage using a pressure transducer module.
10. Measurements using ordinary dual trace oscilloscope
11. To measure the Young's modulus using Cantilever beam instrument and also real time implemention in Lab View.
12. To measure the Hall voltage and current using Hall Effect Transducer trainer.

Extra Experiment (beyond course curriculum)

13. Measurement of unknown frequency by Broken Ring Method.
14. C.T Test by Sillbie's method- error measurement.
15. Measurements using ordinary dual trace oscilloscope
16. To measure the unknown voltage of test circuit using Crompton potentiometer
17. Measurement of power in balanced three phase circuit using two wattmeters.
18. Electro-Physiological Measurement – ECG, EMG, EEG, HEART RATE.

IV SEMESTER B.TECH. (E & E)

EE202A5 **Credit: 1 (L-0, T-0, P-2)**

Project Based Learning-II

Objective: To motivate the students in research/paper publication/practical application which will help them in understanding/analysis/formulating the problem related to the advanced and relevant areas of engineering.

Course Outcome: On successful completion of course students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.

Pre-requisite: None.

Project Based Learning projects should be done by the students starting from 1st semester for which a teacher is assigned to the student(s) under whom he/she/they will work. Project Based Learning-II is the part of the curriculum in Semester-IV with credit 1.0. This is in continuation with **Project Based Learning –I** (**Semester-III**). Minimum contact hour per week is 2 hrs.

SCHEME

YEAR	FIFTH SEMESTER					
	Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
III	EE301A1	Power Electronics	3	1	0	4
	EE302A1	Linear Control Systems	3	1	0	4
	EE303A1	Power System-I	3	1	0	4
	EE304A1	Digital System Design	3	1	0	4
	EE3XXA3	Program Elective-III *	2	1	0	3
	EE3XXA2	Open Elective-III/Minor/NCC *	3	1	0	4
	EE301A4	Advance programming Lab	0	0	2	1
	EE302A4	Control Lab	0	0	2	1
	EE301A5	Project Based Learning- III	0	0	2	1
	EE301A9	Industrial Training-I	0	0	2	1
	GN301A1	Quantitative Aptitude and Logical Reasoning-I	1	0	0	1
	EE308A2	Data Structures and Algorithms (MAC)	2	0	0	0
	MAC: Mandatory audit course		20	6	8	28
	Total Contact Hours (L + T + P)		34			

PROGRAM ELECTIVE-III					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE301A3	Latest Trends in Electrical and Electronics Engineering	2	1	0	3
EE302A3	EHV AC & DC Transmission	2	1	0	3
EE303A3	Embedded Systems	2	1	0	3

OPEN ELECTIVE-III / Specialization					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE301A2	Renewable Energy Systems	3	1	0	4
EE302A2	Wave Guides & Antenna	3	1	0	4
EE303A2	VLSI Design	3	1	0	4
EE304A2 / EE301A8	Energy Storage Technology ***	3	1	0	4
EE303A8	EV Power Electronics & Embedded Systems ***	3	1	0	4

*** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**

***** Specialization syllabus attached at the end of the document.**

V SEMESTER B.TECH. (E&E)

EE301A1 **Credit: 4 (L-3, T-1, P-0)**

POWER ELECTRONICS

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to familiarize the students with the fabrication, structure and operation of various power devices and power converters required for the control and conversion of the electrical energy in the desired form.

Course Outcome:

On successful completion of this course, students will be able to

CO1 Describe fabrication, structure, characteristics and operation of various power devices.

CO2 Design gate drive circuit, firing circuits and protection of various power devices. Also, analyze commutation circuits.

CO3 Describe the operation of rectifier circuits its analysis with its applications.

CO4 Describe operation of dc-dc converters, ac regulators, and their applications.

CO5 Evaluate dc-ac converters, inverters and their applications. Also analyze PWM techniques for inverter control.

Pre-requisites: None

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: Silicon Controlled Rectifiers (SCR) and Other Power Semiconductor Devices:	In class	Basic structure, Equivalent circuit, Operation. V-I characteristics, turn-on, turn-off mechanisms, gate characteristics, gate drive requirements, firing circuits, di/dt, dv/dt and overload protection, commutation circuits: Resonant commutation, complementary commutation, auxiliary commutation, calculation of committing components. TRIAC, BJTs, Power MOSFET, IGBT	9	CO 1, CO 2	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 2: Single-phase converters, & Three-phase converters:	In class	Half wave, bridge converters, operation with RL and back emf loads, performance with free wheeling diode, full wave controlled bridge rectifier with controlled free wheeling, effect of source inductance. Fully controlled three-phase converters	9	CO 3	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					

Module 3: DC-DC Converters, AC regulators	In class	Basic principle of time ratio control, constant and variable frequency, Step down and step up chopper, classification of choppers. Single-phase AC voltage regulators.	6	CO 4	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 4: DC-AC Converters	In class	Single phase and three phase bridge inverters, square wave operation, 120 and 180 degree modes, potential diagrams. Qualitative treatment of line commutated inverters.	8	CO 5	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					
Module 5: PWM Inverters, and PWM Technique	In class	Voltage control, Unipolar and Bipolar voltage switching, Harmonic reduction. Sine triangular modulation, space vector modulator.	4	CO 5	PO 1, PO 2, PO 3, PO 4	PSO 1, PSO 2
	** Assignment Topics					

Text Books:

1. Muhammad H. Rashid - Power Electronics- Circuits, Devices and Applications – PHI.
2. P.S.Bimbhra - Power Electronics(scanned book)-Khanna Publishers (2006)

Reference Books:

1. Mohan, TM Undeland, W. P. Robbins – Power Electronics - John wiley and Sons (SEA).
2. Vedam Subramaniam- Power Electronics -New Age International Publications.
3. G.K. Dubey, S.R. Doradla, A. Joshi , Thyristorised Power Controllers, John Wiley & Son (1986)

V SEMESTER B.TECH. (E&E)

EE302A1 **Credit: 4 (L-3, T-1, P-0)**

LINEAR CONTROL SYSTEMS

Questions to be set: 05 (All Compulsory)

Course Objectives:

- Introduction to fundamental aspects of linear control, i.e., developing dynamic models of the process, and control strategies.
- Determine the transient and steady-state performance of 1st and 2nd order system.
- To develop transfer function and controller design.
- Familiarization with root locus techniques and frequency domain analysis for stability and performance determination

Pre-requisites: Knowledge of basic circuit theory and Laplace transform.

Course Outcomes (CO):

CO1 Modeling and determining transfer function of the physical systems through block diagram reduction and signal flow graphs.

CO2 Determine the transient and steady-state performance of 1st and 2nd order system.

CO3 Determine frequency response of a system & design of PID controllers.

CO4 Analysis of stability through root locus plot, Bode plot and Nyquist criterion.

CO5 Design of lag, lead, lag-lead compensator using time and frequency domain approach.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Modeling & Transfer Function	In class	Introduction to Control systems, Classification, comparison of open-loop and closed-loop systems, Representation of control systems by block diagrams, Mathematical models of electrical, mechanical and electromechanical systems, Transfer function and block diagram representations of dc generator. Block diagram reduction, signal flow graphs, Masons gain formula.	8	1		
	**Assignment Topics					
Module 2: Time response of 1st and 2nd order system	In class	Time Response: Step response of first - and second-order systems, underdamped system response, over damped, critically damped system - time domain specifications, Concept of order of system, type of systems. Steady state errors, Error ratio, Static error Constants, Generalized error series. dynamic error coefficients, steady state errors due to Impulse, step, ramp and parabolic inputs.	8	2		
	****Assignment Topics**					
Module 3: Frequency response &	In class	Frequency response of a system, frequency domain specifications. Different types of controller, Proportional control, proportional-plus- integral	8	3		

PID controllers		control, proportional-plus-derivative control. proportional-plus- integral-plus-derivative control, their realization.				
	**Assignment Topics					
Module 4: Stability analysis in time and frequency domain.	In class	Stability- Concept and definition, BIBO stability, location of the roots of the characteristic equation in the S-plane, Routh-Hurwitz stability criterion, Bode Magnitude and phase plots, Concept of gain margin and phase margin. Root locus method, Magnitude and angle criteria, Root locus construction rules for positive K, interpretation of nature of system response from root locus plots. Polar plots, Nyquist criterion for stability, Nyquist diagrams.	8	4		
	****Assignment Topics**					
Module 5: Compensator Design	In class	Control system design, design specifications, series compensation, phase- lag and phase-lead compensation - frequency response approaches, lag-lead compensation.	8	5		
	****Assignment Topics**					

Recommended Books:

1. K. Ogata - Modern Control Engineering.
2. Charles E. Rohrs. James L. Melsa and Donald G. Schultz-Linear Control systems- MGH, 1993.
3. B.C. Kuo- Automatic control system (ED. 7) -PHI, 1995.
4. David K. Cheng - Analysis of Linear System - Adison Wesley, London, 1994.
5. Morris Driels - linear Control Systems Engineering- MGH, 1996.
6. Norman S. Nise- Control System Engineering-Wiley publisher

V SEMESTER B.TECH. (E&E)

EE303A1 **Credit: 4 (L-3, T-1, P-0)**

POWER SYSTEM-I

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To understand the mathematical modeling of different power system components.
- Load flow analysis determines the voltage angle which in turn determines the line flow and losses and the voltage at each bus. Different methods of load flow methods are studied and its advantage and disadvantage are also compared.
- To understand the automatic frequency control of single area and multi area system
- To understand the voltage control strategies practiced in power system

Pre-requisites: Knowledge of Differential Equations, and Numerical Analysis.

Course Outcomes (CO):

CO1	Demonstrate an understanding of the nature and operation of the modern power system, including the behavior of the constituent components and sub-systems.
CO2	Describe the construction, operation and equivalent circuit of transmission line.
CO3	Apply load flow analysis to an electrical power network and interpret the results of the analysis
CO4	Analyse the different techniques of frequency control in power system.
CO5	Analyse the different techniques of voltage control in power system.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Introduction to power system analysis, per unit system, economic load dispatch	In class	**Sub topic 1:** Representation of power systems: One line diagram, impedance & reactance diagrams. **Sub topic 2**: Per unit notation selection & change of base for per unit quantities. Thevenin's model for Power system. **Sub topic 3:** Economic load dispatch neglecting loss and considering losses.	8	1	1,2	1
	**Assignment Topics	Numerical on Per Unit System and economic load dispatch				
Module 2: Modeling of transmission lines, improvement of power factor	In class	**Sub topic 1:** Modeling of short, medium and long transmission line. **Sub topic 2:** Improvement of power factor	6	2	1,2	1
	****Assignment Topics**	Numerical of transmission lines and improvement of power factor				
Module 3: Load Flow Analysis	In class	**Sub topic 1:** Formation of Y bus matrix. **Sub topic 2:** Load flow solution techniques (using bus only) Gauss-Seidel, Newton Raphson (in polar coordinates only), Acceleration factors. **Sub topic 3:** Decoupled, fast Decoupled method.	10	3	1,2	1

	**Assignment Topics	Numerical				
Module 4: Automatic Load Frequency Controller	In class	**Sub topic 1**: Introduction, Speed governing system and modelling. **Sub topic 2:**Turbine modelling, Generator-load modelling. **Sub topic 3:**Steady-state and dynamic response of ALFC loop. The secondary ALFC loop, Integral control. **Sub topic 4:** Introduction, Pool operation, Two area systems, Modeling of tie line.	8	4	1,2	1
	**Assignment Topics	Automatic Load Frequency Controller				
Module 5: Voltage control	In class	**Sub topic 1:** Introduction, Methods of voltage control. **Sub topic 2:** Power capacitors and its application to distribution and transmission system. **Sub topic 3:** Static var system. **Sub topic 4:** Introduction, Elements of an excitation system. Types of excitation system.	8	4	1,2	1
	****Assignment Topics**	Excitation System				

RECOMMENDED BOOKS:

1. A Chakraborti & Halder – Power System Analysis, Operation & Control, PHI
2. Nagrath and Kothari- Modern Power System Analysis (ED.2) - TMH, 1989
3. Stevenson - Elements of Power System Analysis (Ed 3) -MGH, 1975.
4. Elgerd OI - Power system analysis- TMH.
5. Shipley – Matrices & Power Systems – John Willy.

V SEMESTER B.TECH. (E&E)

EE304A1 **Credit: 4 (L-3, T-1, P-0)**

DIGITAL SYSTEM DESIGN

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To impart the basic knowledge about the analog and digital circuits.
- To understand the designing procedure of various asynchronous and synchronous digital system.
- To know about various ADC and DAC.
- To understand basics of computer aided deigning.

Course Outcomes(CO):

After successful completion of this course, students will be able to:

CO1 Ability to identify basic requirements for a design application and propose a cost effective solution.
CO2 The ability to identify and prevent various hazards and timing problems in a digital design.
CO3 To develop skill to build, and troubleshoot digital circuits.
CO4 Explain basic concept of VLSI technology.
CO5 Establish the transformations of analog techniques in the digital world.

** not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Review of Sequential Machine Fundamental and Analysis and Design of synchronous sequential finite state machines**	in class	Concept of memory, general model of sequential machine and classifications, clocked flip flop, SR, D, T arid JK flip- flops, Synchronous analysis process, Design approaches, design *of* next state-decoder and output decoder, design of counters and registers, code sequence detectors. sequential code generators.	12	1		
	****Assignment Topics**	Practice problem based on Synchronous circuits.		1		
Module 2: **Analysis and Design of Asynchronous sequential Finite state Machines**	in class	Need for Asynchronous circuits, Analysis, Cycles and Races, Hazards, Analysis and Design *of* Asynchronous sequential Finite state Machines	5	2		
	****Assignment Topics**	Practice problem based on Asynchronous circuits.		2		
Module 3: **Introduction to system controller design and Linked state machines**	in class	System controller state specification (MDS diagram), timing and frequency considerations, synchronizing systems, state assignments, implementation using ROM, PAL, PLA, Concept of linked state machines.	7	3		
	****Assignment Topics**	Practice problem based on PLDs.		3		
Module 4: **Introduction to VLSI**	in class	Benefits of integration, criteria for evaluating implementation styles, introduction to computer-aided- design.	2	4		

	****Assignment Topics**	Hierarchical model of VLSI design.		4		
Module 5: **Introduction to Modern Digital System Implementation options, Interfacing Units and Methods of A/D conversions**	in class	Mask Programmable gate array, cell based integrated circuits, Sampling, aliasing effect, antialiasing filters, sample and hold circuits, DACs, resistive ladder networks, (Weighted R, R-2R Networks), characteristics of DACs, simultaneous conversion, counter method, continuous A/D dual slope A/D successive approximation technique, characteristics of ADCs, Data acquisition systems.	10	5		
	****Assignment Topics**	Practice problem based on DAC and ADC circuits.		5		

Text Books:

- Malvino and Leach- Digital Principles and Applications- MGH. 1986.
- Thomas L. Floyd – Digital Fundamentals, 10th Edition, Pearson

Reference Books:

- S. Salivahanan & S. Arivazhagan – Degital Circuits and Design, 4th Edition, Vikas Publishing House (P) Ltd.
- A. Anand Kumar – Fundamental of Digital Circuits (Ed.4)-PHI, 2016.

V SEMESTER B.TECH. (E & E)

EE301A4 **Credit: 1 (L-0, T-0, P-2)**

Advance Programming Lab

1. Write a C++ program to add find the highest of three numbers.
2. Write a C++ program to implement use of function and arrays.
3. Write a C++ program to implement classes and objects.
4. Write a C++ program to implement inheritance.
5. Write a Matlab program to perform matrix calculations.
6. Write a Matlab program to perform plotting operations of mathematical functions.
7. Write a Matlab program to set up a Buck converter using SIMULINK.
8. Write a Matlab program to set up a feedback control system.
9. Write a program for Arduino microcontroller to use LEDs and switches.
10. Write a program for Arduino microcontroller to use proximity sensors, temperature sensor and LEDs.
11. Write a program for Arduino microcontroller to display information on a LCD display.
12. Write a program for Arduino microcontroller to control the direction and speed of a DC motor.
13. Write a program for Arduino microcontroller for Home automation.
14. Write a Matlab program to set up a Boost converter using SIMULINK.
15. Write a program for Arduino microcontroller for PID control on DC motor.

V SEMESTER B.TECH.(E&E)

EE302A4 **Credit: 1 (L-0, T-0, P-2)**

CONTROL LAB

Objective: To make the student familiar with different control techniques of LTI system.

Course Outcome: Such hand on experience provides students with critical practical aspects of electrical and electronics control system engineering.

Pre-requisite: Theoretical concept of control system.

1. To study the torque-speed characteristics, step response and to find the transfer function of the d.c. motors.
2. To study the performance characteristics of a d.c. motor angular position control system.
3.To study the time response of variety of simulated Linear systems and to correlate the studies with theoretical values.
4. To study the characteristics of a linear variable differential transformer.
5. To study the performance characteristics of an angular position error detector using two potentiometers.
6.To study the performance of various type of controllers used to control the temperature of an oven.
7. To study the performance characteristics of a d.c. motor speed control system.
8. To study digital control of a simulated system using an 8-bit microprocessor.
9.To study the characteristics of a synchro transmitter receiver pair and use these as torque-synchro and angular error detector.
10. To study the effects of different cascade compensation networks.

Extra Experiments (beyond course curriculum)

11. To study the configuration and evaluate the performance characteristics of a feedback light intensity control system.
12. To study the performance characteristics of an analogue PID controller using simulated systems.
13. To study simple input-output operations of a microprocessor through programmable peripheral interface, 8255.
14. To study the features and characteristics of a number of digital to analog converter circuits including an IC type AD7533.
15. To study the characteristics of a small ac servomotor and determine its transfer function.

V SEMESTER B.TECH.(E&E)

EE301A5 **Credit: 1 (L-0, T-0, P-2)**

PROJECT BASED LEARNING-III

Objective: To motivate the students in research/paper publication/practical application which will help them in understanding/analysis/formulating the problem related to the advanced and relevant areas of engineering.

Course Outcome: On successful completion of course students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.

Pre-requisite: None.

Project Based Learning projects should be done by the students starting from 1st semester for which a teacher is assigned to the student(s) under whom he/she/they will work. Project Based Learning-III is the part of the curriculum in Semester-V with credit 1.0. This is in continuation with **Project Based Learning –II** (Semester-IV). Minimum contact hour per week is 2 hrs.

V SEMESTER B.TECH. (E&E)

EE301A9 **Credit: 1 (L-0, T-0, P-2)**

INDUSTRIAL TRAINING-I

Objective: To familiarize the students with the actual operation in industry.

Course Outcome: On successful completion of course students will:

1. Visualize the practical application of electrical equipment.
2. Able to relate the theoretical knowledge with practical use.
3. Able to develop new concept of operations.

Pre-requisite: Knowledge of basics of Electrical and Electronics Engineering.

Students will carry out Industrial Training I of two weeks after the completion of fourth semester during summer vacation. Report and PPT to be evaluated by the department in 5^{th} semester examination.

V SEMESTER B.TECH. (E&E)

GN301A1 **Credit: 1 (L-1, T-0, P-0)**

QUANTITATIVE APTITUDE AND LOGICAL REASONING - I

Questions to be set: 05 (All Compulsory)

Course Objective: The main aim of introducing "Quantitative Aptitude & Logical Reasoning" to university students is to develop numerical skills among students and to prepare them for various examinations to enhance better job prospects. This initiative is being taken to include essential mathematical principles to build students' confidence. It is expected to expand students' knowledge and foster their logical reasoning and analytical thinking abilities.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO	STATEMENT
CO1	Student will be able to solve variety of simple problems in the space of quantitative domain.
CO2	Students will be able to use data to determine or to deduce other facts from a set of given data of less complexity.
CO3	Students will be able to use shortcuts, tricks and techniques to solve the problems with moderate accuracy.
CO4	Students will be able to demonstrate essential skills pertaining to public speaking, resume writing and telephone etiquette.
CO5	Students will be able to demonstrate basic skills during the placement interviews

Module	Topics to be covered	Topics	Hrs.	CO	PO	PSO
Module 1: **Quantitative Aptitude**	In class	Problems on Trains, Time and Distance, Height and Distance, Time and Work, Simple Interest, Compound Interest, Profit and Loss, Partnership, Percentage, Problems on Ages, Calendar, Clocks, Average, Area, Volume and Surface Area	6	1		
Module 2: **Puzzles, Problem Solving and Analysis**	In class	Sudoku, Number Puzzles, Missing Letter Puzzles, Playing Card Puzzles, Clock Puzzles.	3	2		
Module 3: **Logical Reasoning**	In class	Number Series, Letter and Symbol series, Verbal Classification Essential Part, odd man out and visual reasoning, Analogies, Artificial Language, Matching Definitions, Making Judgements.	5	3		
Module 4: **Professional Builder**	In class	Resume Writing, Public Speaking, Extempore, Telephone etiquette.	4	4		
Module 5: **Use Cases**	In Class	Mock Interview – Hard and Soft Skills Sector: FMCG, IT, Production, Manufacturing etc.	2	5		

Text books:

1. Aggarwal, R. S. (2008). Quantitative Aptitude. S. Chand., ISBN: 9788121924986, 8121924987
2. Devi, S. (2005). Puzzles to puzzle you. Orient Paperbacks., ISBN: 8122200141, 9788122200140

V SEMESTER B.TECH.(E&E)
MADATORY AUDIT COURSE-I

EE308A2 **Credit: 0 (L-2, T-0, P-0)**

DATA STRUCTURES & ALGORITHMS

Questions to be: 05 (All Compulsory)

Course Objectives:

To serve as a beginner course in getting familiar with the concepts and operations in Data Structure and Algorithms and their various applications.

Pre-requisites: Knowledge of C programming.

Course Outcomes (CO):

- **CO1** Understand the concept of Dynamic memory management, data types, algorithms, Big O notation.
- **CO2** Understand basic data structures such as arrays, linked lists, stacks and queues.
- **CO3** Describe the hash function and concepts of collision and its resolution methods.
- **CO4** Solve problem involving graphs, trees and heaps.
- **CO5** Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Introduction data structures and algorithms	In class	**Sub topic 1:** Definition of Data Structure, Importance of Data Structure, Algorithms and their different complexities, Big Oh. **Sub topic 2**: Representation of multidimensional arrays, Highly structured sparse matrices using dimensioned arrays.	8	1	1,2	1
	**Assignment Topics	Programing				
Module 2: Stacks	In class	**Sub topic 1:** Definition, Operations on stacks, Implementation using array. Application of Stacks: **Sub topic 2:** Evaluation of arithmetic expressions. Recursion: Use of recursive techniques in enumeration problems and back tracking algorithms, Recursion removal using stacks.	6	2	1,2	1
	****Assignment Topics**	Programing				
Module 3: Queue, Non-Contiguous data structure.	In class	**Sub topic 1:** Definition, Operations on queue, Implementation of queues, Circular queues, Applications. **Sub topic 2:** Linear linked list: Insertion, Traversal and deletion operations on singly linked list. Various types of linked list: Doubly linked list, Circular lists, **Sub topic 3:** Use of header node in circular lists, Generalized (recursive) list, Application of linear list.	10	3	1,2	1
	**Assignment Topics	Programming				
Module 4: Trees	In class	**Sub topic 1:** Definition of a tree and various terminologies used in tree, Binary tree, Recursive	6	4	1,2	1

		and non-recursive tree traversal algorithms, Representation of n-array trees using binary trees, Application of trees, Expression trees. Search trees: **Sub topic 2:** Definition, Insertion, Deletion and reversal, Height balanced search trees (using AVL trees illustrative example) and weight balanced search trees.				
	****Assignment Topics**	Programming				
Module 5: Graphs, Sorting and searching	In class	**Sub topic 1:** Terminology and representations: Introduction, Definition and terminology, Graph representations, Traversals, connected components and spanning trees, Shortest path problem, Dijkstra's algorithm. **Sub topic 2:** Sorting: Insertion, 2-way merge, Heap sort and quick sort, Comparison of different sorts, Hashing technique: Hash tables, Different hashing functions, Overflow handling, Methods for collision handling, Theoretical evaluation.	6	5	1,2	1
	****Assignment Topics**	Programming				

RECOMMENDED BOOKS:

1. Data Structures and Algorithms – O.G. Kakde & U.A. Deshpandey, ISTE/EXCEL BOOKS
2. Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., "Data Structures and Algorithms", Addison Wesley
3.Heileman:data structure algorithims &Oop Tata McGraw Hill
4. Data Structures Using C – M.Radhakrishnan and V.Srinivasan, ISTE/EXCEL BOOKS
5. Weiss Mark Allen, "Algorithms, Data Structures, and Problem Solving with C++", Addison Wesley.

SCHEME

Year	SIXTH SEMESTER					
III	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**C**
	BA346A1	Industrial Management	2	0	0	2
	EE305A1	Power System-II	3	1	0	4
	EE306A1	Advanced Control Theory	3	1	0	4
	EE3XXA3	Program Elective-IV	3	1	0	4
	EE3XXA3	Program Elective-V	3	1	0	4
	EE3XXA2	Open Elective-IV/Minor	3	1	0	4
	EE303A4	Power Electronics and Drives Lab	0	0	2	1
	EE304A4	Power System Lab	0	0	2	1
	EE302A5	Mini Project	0	0	2	1
	GN302A1	Quantitative Aptitude and Logical Reasoning-II	1	0	0	1
	EE309A2	Basics of Java (MAC)	2	0	0	0
	MAC: Mandatory audit course		20	5	6	26
	Total Contact Hours (L + T + P)		31			

PROGRAM ELECTIVE-IV					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE304A3	Electrical Drives	3	1	0	4
EE305A3	Electrical Machine Design	3	1	0	4
EE306A3	Flexible AC Transmission Systems	3	1	0	4

PROGRAM ELECTIVE-V					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE307A3	High Voltage Engineering	3	1	0	4
EE308A3	Digital Signal Processing	3	1	0	4
EE309A3	Modern Power Converters	3	1	0	4

OPEN ELECTIVE-IV/ Specialization					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE305A2	Advanced Methods in Control Theory	3	1	0	4
EE306A2	Machine Learning	3	1	0	4
EE307A2	Digital Image Processing	3	1	0	4
EE310A2 / EE302A8	Foundations of Optimization ***	3	1	0	4
EE304A8	EV Charging Infrastructure, Vehicle Testing & Homologation ***	3	1	0	4

*** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**

***** Specialization syllabus attached at the end of the document.**

VI SEMESTER B.TECH.(E&E)

BA346A1 **Credit: 2 (L-2, T-0, P-0)**

INDUSTRIAL MANAGEMENT

Questions to be set: 05 (All compulsory)

Course Objective: To provide basic knowledge of functions of management along with their practical implications

Pre-requisites: No pre-requisites

Course Outcomes (CO):

CO1: To provide basic knowledge and application of functions of management

CO2: To help students to understand and apply principles of management evolved by pioneers of management.

CO3: To enable students to apply basic quantitative techniques for making decisions related to operations management

CO4: To help student apply various techniques for optimal production management

CO5: To apply concepts of materials management for maintaining optimal inventory

** Not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Introduction	In Class	Philosophy and Development of Management thought. Concept and definition of management, Functions and Roles of Management, Social Responsibilities of Management.	3	1		
	** Assignment Topics			1		
Pioneers in Management	In Class	Taylor's Scientific Management, Contribution of Henry Fayol, Maslow, McGregor, Gilbreth and Mayo.	3	2		
	** Assignment Topics			2		
Quantitative Techniques in Managerial Decisions	In Class	Concept of budget and budgetary control. Time-event network analysis; ABC Analysis, Break-even Analysis; Decision Tables; Concept of productivity, measuring productivity, Use information technology	5	3		
	** Assignment Topics			3		
Production Management	In Class	Types of production; Types of Planning, Manufacturing Planning; Production planning, Scheduling; Work study & Method Study; Systems of wage payments, bonus, Automation. Organization of production, planning and control department.	5	4		
	** Assignment Topics			4		
Materials Management	In Class	Practice of purchasing and materials management, quality, Inventory Management, EOQ model; Value Analysis and Value Engineering.	4	5		
	** Assignment Topics			5		

Text Books:

a) H. Koontz and H. Weihrich, “Management”, McGraw Hill
b) Dobler W.D. “Purchasing & Materials Management”, TMHC, New Delhi

VI SEMESTER B.TECH.(E&E)

EE305A1 **Credit: 4 (L-3, T-1, P-0)**

POWER SYSTEM-II

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To understand the different fault condition and types of faults.
- To understand different stability issues and its control measures in power system.
- To understand use and operation of different types of relays for different components of a power system.
- To understand use and operation of different types of circuit breakers in power system.

Pre-requisites: Knowledge of Power System Analysis.

Course Outcomes (CO):

CO1	Analysing and modelling different fault situation in power system.
CO2	Analysing stability issues and to measure stability limit of a power system
CO3	Analyze operation and performance of relay for power system protection.
CO4	Design protection system for different components of power system.
CO5	Analyze different types of circuit breaker.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Symmetrical and unsymmetrical Faults	In class	**Sub topic 1:** Symmetrical 3 phase faults: Short circuit currents and reactance of Synchronous machines. Short circuit current calculations of unloaded & loaded Generators and power systems. **Sub topic 2:** Sequence impedance's and networks of power system elements. Analysis of unsymmetrical faults in generator and power system under no load.	8	1	1,2	1
	****Assignment Topics**	Numerical on fault analysis				
Module 2: Stability analysis	In class	**Sub topic 1:**Introduction to Power system Stability **c**lassification. **Sub topic 2:**Small signal and Transient stability, Rotor angle & Voltage Stability. **Sub topic 3:**Stability problem, swing equation and its numerical solution.	8	2	1,2	1
	****Assignment Topics**	Equal area criterion				
Module 3: (Operation and performance of relay)	In Class	Functions of protective relaying, Fundamental characteristics of relays, and Standard definition of relay terminologies, Relay classifications, operating principles of single and double actuating quantity type electromechanical relays. Directional relay, reverse power relay.	8	3	1,2	1
	Assignment Topics					
Module 4:	In Class	Differential protection schemes for Bus	8	4	1,2	1

(Relay for different components of power system)		bars, Transformer and Alternator. Buchholtz relay for Transformer protection. Line protection: Various types of Distance relays, performance of distance relays. Induction Motor Protection: Abnormal operating conditions, Contactors and circuit breakers for motors. Solid state relays: Phase and amplitude comparators, Duality between phase and amplitude comparators, general equation for comparators. Computer aided relaying: Introduction to microcomputer based relays.				
	Assignment Topics					
Module 5: (Circuit Breaker)	In Class	Circuit breakers- principle of working, arc phenomenon, methods of arc extinction, recovery and restriking voltage. Circuit breaker ratings- breaking capacity , making capacity, various times associated with circuit breakers, Oil circuit backers and air circuit breakers- construction, principle of working, merits and application SF6 circuit breaker, principle, construction of different, working, merits and application of SF6 breakers. Vacuum circuit breaker, arc extinction in vacuum, working, construction and application of vacuum circuit breakers.	8	5	1,2	1
	Assignment Topics					

RECOMMENDED BOOKS:

1. Electric Energy Systems Theory an Introduction - Olle I. Elgerd
2. Power Generation Operation and Control - A.J. Wood, B.F. Wollenberg
3. Power System Deregulation by Loi Lei Lai
4. Power System Stability and Control - P. Kundur
5. S. S. Rao - Switchgear and Protection - Khanna Publishers, N.Delhi, 1990.
6. I. J. Nagrath and D. P. Kothari _ Power System Engineering, TMH, 1994

VI SEMESTER B.TECH.(E&E)

EE306A1 **Credit**:**4 (L-3, T-1, P-0)**

ADVANCED CONTROL THEORY

Questions to be set: 05 (All Compulsory)

Course Objectives: The objective of this course is to provide an introduction to basic concepts and methodologies for Advance Control Theory. The limitation of transfer function model in analysis of control system and the advantages of state space model over the transfer function model for the system design. Study of non-linear systems and discrete domain systems.

Pre-requisites: Knowledge of Linear Control System.

Course Outcomes (CO): On successful completion of this course, students will be able to

CO1 To design any physical system in state space domain.
CO2 To analyse the stability criterion of any system in state space
CO3 To model and control any non-linear system
CO4 To evaluate a controllable and observable system
CO5 To model and control any discrete system

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (State Space Analysis)	In Class	Introduction to State Space Analysis, Concept of State, State models of mechanical systems, State models of electrical systems, Realization of state models from transfer functions, Solution of state equation, State Transition Matrix, Cascade Decomposition, Parallel Decomposition, Cayley-Hamilton theorem.	8	1	1,3	2
	Assignment Topics					
Module 2 (Stability in state space)	In Class	Asymptotic and BIBO Stability, Lyapunov first method of stability, Lyapunov second method of stability, Lyapunov stability theorem, Lyapunov Krasovskii stability theorem, Variable Gradient Method.	8	2	1,2,4	2
	Assignment Topics					
Module 3 (Non-Linear System)	In Class	Commom Physical Non linearities, Derivation of describing function for relays, Derivation of describing function for relays, Derivation of describing function for relays with dead zone and hysteresis, Stability Analysis by Describing Functions, Basic concepts of Phase Plane Method, Singular points, Phase trajectory	8	3	1,2,5	2
	Assignment Topics					
Module 4	In Class	Controllability criterion Gilbert's test, Kalman's test, Factor's cancellation	8	4	1,2,3	2

(Evaluation of Controllability and Observability)		test and PBH test. Observability criterion Gilbert's test, Kalman's test, Factor's cancellation test and PBH test.				
	Assignment Topics					
Module5 (Digital Control System)	In Class	Ideal sampler, sampling process, Shannon's sampling theorem, Z transform, Inverse Z transform, Pulse transfer function, Jury's stability criterion	8	5	1,3	2
	Assignment Topics					

RECOMMENDED BOOKS:

1. K.Ogata-Modem Control Engineering (ED.2)-PHI, 1995.
2. KOgata-State Space Analysis of Control Systems-PHI, 1967.
3. M.Gopal-Digital Control engineering- Wiley Eastern, 1988.
4. Charles LPhillips and Royee D. Harbor- Feed Back Control systems (ED.2)- PHI, 1991

VI SEMESTER B.TECH. (E & E)

EE303A4 **Credit: 1 (L-0, T-0, P-2)**

POWER ELECTRONICS AND DRIVES LAB

Objectives: To have hands-on exposure to operation of various power electronics converters and devices. To learn diagnosing and testing the characteristics of power converters and verifying the operating principles. Practical Exposure of various motor drives. Speed control techniques in open loop and closed loop.

Course Outcome: Operational steady state characteristic of the various power devices. Operating different power converters, checking the waveforms at various test points. Exposure to different schemes of ac and dc motor control. Exposure to different schemes of ac and dc motor control in simulation platform and PLC.

Pre-requisites: Knowledge of power electronics, dc and ac motors.

1. Observe and study various forced commutation techniques of SCR
   i. Self-Commutation
   ii. impulse Commutation

   Determine the average output voltage at
   a) constant frequency, variable duty ratio,
   b) constant duty ratio, variable frequency,
   c) frequency at which commutation fails and
   d) device and circuit turn-off time in each commutation technique mentioned above.

2. Observe and study various forced commutation techniques of SCR
   i. Resonant Commutation
   ii. Complementary Commutation.

   Determine the average output voltage at
   e) constant frequency, variable duty ratio,
   f) constant duty ratio, variable frequency,
   g) frequency at which commutation fails and
   h) device and circuit turn-off time in each commutation technique mentioned above.

3. Observe and study output voltage waveform of a
   i. single – phase Full-wave, fully-controlled AC-DC converter under different load conditions.
   ii. 3-phase half wave uncontrolled rectifier

   Determine the output average voltage, ripple factor and circuit turn-off time. Also check the effect of freewheeling diode on the input power factor of the converter.

4. Operate Buck DC-DC converter at (a) constant frequency; variable duty ratio and (b) constant duty ratio; variable frequency. Also determine the device and circuit turn-off time.

5. Study and plot the static V-I and Transfer characteristics of
   i. MOSFET
   ii. IGBT

6. Observe and study output voltage waveform of SCR based AC phase controller.

7. Control of output devices (bulbs) using PLC timers.

8. Control the LEDs output using proximity/limit switch and PLC. Write a program to switch on the LED using simple NO and NC switch.

9. To start a motor using button switch then let it rotate to a particular number of revolutions after which it stops automatically.

10. Speed control of 3-phase squirrel cage induction motor by voltage control and voltage frequency control by V/F method (by using digital/Analog keypad of PWM based AC motor drive system).

11. Study of IGBT based 3-phase AC motor drive.

12. Study of Phase Controlled Rectified DC Motor Drive using a Full Converter

13. Study of Chopper Controlled DC Motor Drive

14. Construct a 3-phase VSI (Voltage Source Inverter) in either 180-degree or 120-degree conduction mode in MATLAB/Simulink Platform.

15. To demonstrate the speed control of DC motor in MATLAB/Simulink Platform.

VI SEMESTER B.TECH.(E&E)

EE304A4 **Credit: 1 (L-0, T-0, P-2)**

POWER SYSTEM LAB

Objectives: To have practical exposure for fault analysis in power system, load flow analysis and power system protection devices.

Course Outcome: Conversant with protection of different power system equipment. Simulation of power system faults.

Pre-requisites: Knowledge of subject Power system analysis.

1. Determination of ABCD parameter of scale down model of a 620 MVA, 275 kV, 400 km transmission line using AC network analyzer.
2. Study of differential protection of 3-Phase alternator.
3. Study of differential protection of 3-Phase transformer.
4. Time-Current characteristics of an over current relay.
5. Tie-Line modeling of multi area AGC system in Simulink environment.
6. Load flow analysis using ETAP.
7. Fault analysis using PSCAD.
8. Determination of I-V Characteristics of solar panel.
9. Demand response analysis using Energy plus and BCVTB.
10. Grid integration of solar energy.
11. MPPT for Photovoltaic Power System.
12. Microcontroller based static VAR compensator.

VI SEMESTER B.TECH.(E&E)

EE302A5 **Credit: 1 (L-0, T-0, P-2)**

MINI PROJECT

Objective: To motivate the students for practical application of knowledge gain.

Course Outcome: On successful completion of course, students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.
4. Design and development of electrical and electronics devices.
5. Analysis of electrical circuits through circuits simulation softwares like LTSpice & MATLAB.

Pre-requisite: Knowledge of Electrical and Electronics Engineering subjects taught.

Mini project should be done by the students in sixth semester for which a teacher is assigned to the student(s) under whom he/she/they will work. Minimum contact hour per week is 4 hrs.

VI SEMESTER B.TECH. (E & E)

GN302A1 **Credit: 1 (L-1, T-0, P-0)**

QUANTITATIVE APTITUDE AND LOGICAL REASONING - II

Questions to be set: 05 (All Compulsory)

Course Objective:

The key objective of this course is to strengthen the numerical skills and logical abilities & skills of university students and prepare them for various competitive exams, thereby improving their employment opportunities. This initiative aims to incorporate fundamental mathematical principles to build students' confidence. Additionally, it seeks to broaden their knowledge and foster their logical reasoning and analytical thinking skills.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO	STATEMENT
CO1	Student will be able to solve variety of problems simple to complex in the space of quantitative domain.
CO2	Students will be able to use data to determine or to deduce other facts from a set of given data which are simple to complex.
CO3	Students will be able to use shortcuts, tricks and techniques to solve the problems with high accuracy.
CO4	Students will be able to demonstrate essential skills pertaining to business communications.
CO5	Students will be able to demonstrate advanced skills required at the time of placement interviews.

Module	Topics to be covered	Topics	Hrs.	CO	PO	PSO
Module 1: **Quantitative Aptitude**	In class	Problems on Permutations and Combinations, Probability, Numbers, Problems on Numbers, Problems on HCF and LCM, Decimal Fraction, Simplification, Square Root and Cube Root, Surds and Indices, Ratio and Proportion, Chain Rule, Pipes and Cistern, Boats and Streams, Allegation and Mixtures, Logarithm, Races and Games, Stocks and Shares, Probability, True Discount, Odd man out and Series.	8	1		
Module 2: **Puzzles, Problem Solving and Analysis**	In class	Logical Connectives and Syllogisms, Data Interpretation, Cases, Venn Diagrams.	3	2		
Module 3: **Logical Reasoning**	In class	Verbal Reasoning, Logical Problems, Logical Games, Data Arrangement and Blood Relations, Analyzing Arguments, Statement and Assumption, Course of action, Statement and Conclusion, Theme Detection, Cause and Effect, Statement and Argument, Logical Deduction.	4	3		
Module 4: **Professional Builder**	In class	CV Writing, Verbal & Non Verbal Communication, Group Discussion, Netiquettes,	2	4		
Module 5: **Use Cases**	In Class	Mock Interview on Hard and Soft Skills Sector - IT, FMCG, Product, Financials, Manufacturing, Production, Construction etc.	3	5		

Text books:

1. Aggarwal, R. S. (2008). *Quantitative Aptitude*. S. Chand., ISBN: 9788121924986, 8121924987
2. Devi, S. (2005). *Puzzles to puzzle you*. Orient Paperbacks., ISBN: 8122200141, 9788122200140

VI SEMESTER B.TECH. (E & E)
MADATORY AUDIT COURSE-II

EE309A2 **Credit: 0 (L-2, T-0, P-0)**

BASICS OF JAVA

Questions to be set: 05(All compulsory)

Course objectives:

1. Expertise in object-oriented programming.
2. Know constructs and inheritance of java programs.
3. Understand packages of java program.

Pre Requisites: Basics of computer and programming knowledge in C.

Course outcomes:

1. Understand basic of Java OOPs programming environment
2. Utilize basic constructs, basic programming using classes and objects.
3. Understand advanced concept of inheritance/exceptions/interfaces.

Module	Topics to be covered in class	Topics	Hrs	CO	PO	PSO
Module 1	In class	History and introduction of java programming, bytecode, keywords, JVM, JRE. Platform independence, comparison with C++, features of Java.	6	1	1,5	1,2
	Assignment topics					
Module 2	In class	Primitive datatype, literals, variables, operators, precedence. Precedence, Associativity, methods and overloading of methods.	6	1	1,5	1,2
	Assignment topics					
Module 3	In class	Conditional statements: If else, for, while, switch, statements and usage. String handling, new keyword, constructors, final keyword.	6	1,2	1,5	1,2
	Assignment topics					
Module 4	In class	Inheritance, access modifiers, interface, abstract class, Methods, overriding, overloading, arrays, definition, multi dimension array	6	1,2	1,5	1,2
	Assignment topics					
Module 5	In class	Classes, inheritance, abstract class. Packages of Java programming, lifecycle of thread, multi-threading. Introduction to applets	6	2,3	1,5	1,2
	Assignment topics					

Textbooks:

1. E.Balagurusamy, Programming with JAVA- A Primer, 3/e, Tata McGraw Hill, 2007. ISBN-10:0-07-061713-9.
2. Herbert Schildt, "Java: The Complete Reference", Tata McGraw Hill.

Reference Books:

3. K. Arnold and J. Gosling, "The Java Programming Language", Addison Wesley.

SCHEME

YEAR	SEVENTH SEMESTER					
	Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
IV	EE4XXA2	Open Elective - V/Minor *	3	1	0	4
	EE4XXAX	Choice Based Elective *	3	0	0	3
	EE401A6	Major Project – Phase I	0	0	20	10
	EE401A9	Industrial Training-II	0	0	2	1
			6	1	22	18
	Total Contact Hours (L + T + P)		29			

OPEN ELECTIVE-V / Specialization					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE401A2 / EE401A8	Basics of Data Science with Python Programming***	3	1	0	4
EE402A2	Bio Medical Instrumentation	3	1	0	4
EE403A2 / EE402A8	Smart Grid ***	3	1	0	4
EE405A8	EV Vehicle Design & Analysis ***	3	1	0	4

*** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**

***** Specialization syllabus attached at the end of the document.**

VII SEMESTER B.TECH. (E&E)

EE401A6 **Credit:10 (L-0, T-0, P-20)**

MAJOR PROJECT – Phase I

Objective: To familiarize the students with Industrial technical problems.

Course Outcome: On successful completion of course students will:

1. Able to Identify and resolve the actual industrial problems
2. Come up with innovative ideas.
3. Visualize the practical application of electrical equipment.
4. Able to relate the theoretical knowledge with practical use.
5. Able to develop the interpersonal and managerial skills.

Pre-requisite: Knowledge of Electrical and Electronics Engineering.

VIIth semester student(s) will have to undergo minimum of 16 weeks **RESEARCH BASED PROJECT/INDUSTRIAL PROJECT** work on live industrial problems preferably in the industries. However, the student(s) can do major project work in any R & D lab /organization/institution of good repute. During their major project, students are required to submit progress of their work in phases to make the department aware of his/ her project. At the end of 16 weeks, student(s) have to report to the internal guide/faculty member for the final refinement and documentation. The project is evaluated through internal presentation before the panel of faculty members followed by the evaluation by external examiner appointed by the university.

VII SEMESTER B.TECH. (E&E)

EE401A9 **Credit:1 (L-0, T-0, P-2)**

INDUSTRIAL TRAINING- II

Objective: To familiarize the students with the actual operation in industry.

Learning Outcome: On successful completion of course students will:

1. Visualize the practical application of electrical equipment.
2. Able to relate the theoretical knowledge with practical use.
3. Able to develop new concept of operations.

Pre-requisite: Knowledge of basics of Electrical and Electronics Engineering.

After completion of VIth semester, students do their Industrial Training II of four weeks during summer vacation at different industries/establishments. Report and PPT to be evaluated by the department in 7th semester examination.

SCHEME

Year	EIGHTH SEMESTER					
IV	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**C**
	EE4XXA2	Open Elective - VI/ **Minor ***	3	1	0	4
	EE402A6	Major Project – Phase II	0	0	18	9
			3	1	18	13
	Total Contact Hours (L + T + P)		22			

OPEN ELECTIVE-VI/ Specialization					
Subject Code	**Subject Name**	**L**	**T**	**P**	**C**
EE404A2 / EE403A8	Advance Power Converters ***	3	1	0	4
EE405A2 / EE404A8	Power Electronics for Renewable Energy Technologies ***	3	1	0	4
EE406A8	EV PCB Design & Data Analytics ***	3	1	0	4

*** Upto maximum of 40% of the total credits in a particular semester through MOOCs Swayam NPTEL Platform. Under special circumstances, 20% of the core credits may be earned through MOOCs in a particular semester after approval of DAC, AD(A), and HOI. However, under no circumstances shall be credits earned via MOOCs Swayam NPTEL exceed 40% of the total credit per semester.**

***** Specialization syllabus attached at the end of the document.**

VIII SEMESTER B.TECH. (E&E)

EE402A6 **Credit:9 (L-0, T-0, P-18)**

MAJOR PROJECT- PHASE-II

Objective: To familiarize the students with Industrial technical problems.

Course Outcome: On successful completion of course students will:

1. Able to Identify and resolve the actual industrial problems
2. Come up with innovative ideas.
3. Visualize the practical application of electrical equipment.
4. Able to relate the theoretical knowledge with practical use.
5. Able to develop the interpersonal and managerial skills.

Pre-requisite: Knowledge of Electrical and Electronics Engineering.

VIIIth semester student(s) will have to undergo minimum of 16 weeks **RESEARCH BASED PROJECT/INDUSTRIAL PROJECT** work on live industrial problems preferably in the industries with may be the continuation of the **INDUSTRIAL PROJECT- PHASE-I (VII Sem)** . However, the student(s) can do major project work in any R & D lab /organization/institution of good repute. During their major project, students are required to submit progress of their work in phases to make the department aware of his/ her project. At the end of 16 weeks, student(s) have to report to the internal guide/faculty member for the final refinement and documentation. The project is evaluated through internal presentation before the panel of faculty members followed by the evaluation by external examiner appointed by the university.

ELECTRICAL & ELECTRONICS ENGINEERING

(PROGRAM ELECTIVES)

III SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-I

EE201A3 **Credit: 4 (L-3, T-1, P-0)**

ELECTROMAGNETIC THEORY

Questions to be set:05 (All Compulsory)

Course Objectives:

- To provide an understanding of co-ordinates system and vector analysis.
- To learn about the electromagnetic and electrostatic field and its applications.
- To be able to analyze transmission of charge.
- To provide knowledge about wave propagation.

Pre-requisites: Knowledge of basic vector calculus and co-ordinate system, concept of electrostatics.

Course Outcomes (CO):

CO1 Analysis the basic mathematical concepts related to vector calculus and coordinate system.

CO2 Realize the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.

CO3 Demonstrate the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.

CO4 Demonstrate the concepts related to Faraday‘s law, induced emf and Maxwell‘s equations.

CO5 Analysis Maxwell‘s equations to solutions of problems relating to transmission lines and uniform plane wave propagation.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: The Co-ordinate Systems and revision of vector calculus	In class	**Sub topic 1:**The Co-ordinate Systems, Revision of vector calculus. **Sub topic 2**: Electrostatics: Electric Flux and Flux Density. **Sub topic 3:**Gauss‘s law -Energy and Potential **Sub topic 4:**Capacitors and Capacitances-Method of Images	7	1	1,2	1
	**Assignment Topics	Numerical on Co-ordinate Systems.				
Module 2: Steady Electric Currents and Faraday‘s Law of Induction	In class	**Sub topic 1:** The Equation of Continuity. Joules law- Magnetostatics: The Biot-Savart law. Ampere’s Force Law - Magnetic Vector Potential.- Ampere‘s Circuital law. **Sub topic 2:** Self and Mutual inductance. Maxwell‘s Equations from Ampere‘s and Gauss‘s Laws. Maxwell‘s Equations in Differential and Integral forms; Equation of Continuity	8	2	1,2	1
	****Assignment Topics**	Numerical on related topics.				
Module 3:	In class	**Sub topic 1:**Concept of Displacement Current.	6	3	1,2	1

Concept of Displacement Current		**Sub topic 2:**Electromagnetic Boundary Conditions				
	**Assignment Topics	Numerical on related topics.				
Module 4: Plane wave Propagation	In class	**Sub topic 1:**Helmholtz wave Equation-Plane wave solution.-Plane wave propagation in lossless and lossy dielectric medium and conducting medium. **Sub topic 2:**Polarization of EM wave - Linear, Circular and Elliptical polarization	8	4	1,2	1
	****Assignment Topics**	Numerical on related topics.				
Module 5: Transmission Lines	In class	**Sub topic 1:**LCR ladder model for transmission lines. **Sub topic 2:**Solution for lossless lines. Wave velocity and wave impedance	7	5	1,2	1
	****Assignment Topics**	Numerical on related topics.				

RECOMMENDED BOOKS:

1. Cheng, D.K., "Field and Wave Electromagnatics", Pearson Education (Singapore) Pte. Ltd., 2nd Edn., 1989.
2. Hayt, W.H., J.A. Buck, "Engineering Electromagnetics", Tata McGraw Hill.
3. Edward C. Jordan & Keith G. Balmain, "Electro-magnetic waves & Radiating System", PHI.
4. Deepak Sood, "Field & Wave, A Fundamental Approach", University Science Press.
5. S. C. Matapatra, SudiptaMahapatra, "Principles of Electromagnetics", Tata McGraw Hill.
6. Matthew Sadiku, "Principles of Electromagnetics", Oxford University Press.
7. A.R. Harish, M. Sachidananda, "Antennas & Wave Propagation", Oxford University Press.

III SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-I

EE202A3 **Credit:4(L-3, T-1, P-0)**

FUNDAMENTALS OF NANO-ELECTRONICS

Questions to be set: 05 (All Compulsory)

Course Objectives: To learn fundamentals of nano-electronics and nanotechnology. To learn application and recent advancement in the field of nano-electronics and nanotechnology. To be aware with all Nano materials and their characteristics.

Pre-requisites: Knowledge of basic analog electronics devices and principles.

Course Outcomes (CO): On successful completion of this course, students will be able to

CO1 Analyze different nanostructured materials
CO2 Characterize different nanomaterials using characterization technique.
CO3 Apply nano-electronics technologies to solve engineering problems.
CO4 Design nano-electronics system using quantum dots and quantum wires
CO5 Apply microscopy tools for nano-electronics

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (Nanostructure material)	In Class	Introduction to (i) Carbon Nano tubes (CNTs) - Single-walled Carbon Nano tubes (SWCNTs), Multi-walled Carbon Nanotubes (MWCNTs), BN Nano tubes, (ii) Carbon Nano fibres (CNFs), (iii) Nanowires, (iv) Nanocomposites, (v) Nanocones (vi) Nanorods.	7	1		
	**Assignment Topics					
Module 2 (Characterization of nanomaterial)	In Class	Characterization Techniques of Nanomaterials: 1) Scanning Probe Microscopy: Atomic Force Microscopy (AFM), Scanning Tunnelling Microscopy (STM) - Characterization and sample preparation techniques. 2) Electron Microscopy- Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) - Characterization and sample preparation techniques. 3) Thermo-physical characterization: Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA). 4) Electrical Characterization: Electrical conductivity and Dielectric properties of materials., Nano filled resin for cast insulator, capacitors etc.	8	2		

	**Assignment Topics					
Module 3 (Nanoelectronics technology)	In Class	Introduction, fundamental concepts, technological evolution. Basic Nanoelectronic Technologies- Single Electron Devices, Quantum Mechanical Tunnel Devices, Spin Nanoelectronics (Spintronics), Molecular Nanoelectronics, Quantum Computing	7	3		
	**Assignment Topics					
Module 4 (Nanoelectronics system)	In Class	Quantum Dots and Quantum Wires (determination of resistance, charge concentration, charge mobility), Fabrication Methods and Techniques for Nanoelectronics	7	4		
	**Assignment Topics					
Module5 (Microscopy)	In Class	Microscopy Tools for Nanoelectronics, Microelectromechanical Systems (MEMS) and Microoptoelectromechanical Systems (MOEMS) Applications.	7	5		
	**Assignment Topics					

RECOMMENDED BOOKS:

1. S. Saito, A. Zettl- Carbon Nanotubes: Quantum Cylinders of Graphene
2. Daniel Minoli- Nanotechnology Applications to Telecommunications and Networking
3. Badih El-Kareh- Silicon Devices and Process Integration: Deep Submicron and Nano-Scale Technologies
4. Research papers/conference proceedings.

III SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-I

EE203A3 **Credit:4 (L-3, T-1, P-0)**

ANALOG AND DIGITAL ELECTRONICS

Questions to be set: 05 (All Compulsory)

Course Objectives: To provide an understanding about semiconductor devices. Characteristics of P-N junction diode and effect of temperature. To be able to analyze biasing of transistors and methods of transistor biasing. Knowledge about BJT, MOSFET and other devices. Specification and various applications. To provide a basic understanding and learn about the elements or building blocks of digital circuits and systems, the methods and approaches leading to their practical design and real-time implementation. To be able to analyse, design and evaluate digital systems.

Pre-requisites: Understanding of semiconductor devices, it's construction, operation, and applications. Elementary concept of basic electronics such as diodes, transistors and elements of electrical circuits.

Course Outcomes (CO): On successful completion of this course, students will be able to

CO	Statement
CO1	Understand the characteristics of diode and it's applications. Learn the basics of number systems and binary codes.
CO2	Understand the concepts of BJT, FET and their applications. Learn the basics of logic gates.
CO3	Analysis of all modes of transistor and it's characteristics and gain factors. Apply Boolean algebra for representation of digital logic.
CO4	Design and analysis of transistor biasing and stability of all configurations. Construct basic combinational circuits using digital logic design procedures.
CO5	Understand the concepts of an amplifiers and oscillators and all types of FET. Apply design procedures to design basic sequential circuits.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Number Systems and Codes, P-N Junction .	In class	**Sub topic 1:** Number Systems (Binary, decimal, octal, hexadecimal), Number system conversions, Binary Codes (Numeric and Alphanumeric codes.), Arithmetic operations (Binary arithmetic-addition, subtraction, multiplication and division. **Sub topic 2:** Open circuited P-N Junction, Bias conditions, The current components in a P-N Junction diode, The volt-ampere characteristics Reverse saturation current, Breakdown.	7	1	1,2	1
	**Assignment Topics	Numericals.				
Module 2:	In class	**Sub topic 1: Logic Gates (**OR, AND, NOT, XOR, XNOR, NOR and NAND gates, truth tables)	7	2	1,2	1

Logic Circuits, Diode circuits		**Sub topic 2:** Diode as a circuit element, load-line concept , Diode model, clipping circuits, clipping at two independent levels, clamping circuits and rectifiers				
	****Assignment Topics**	Numericals.				
Module 3: Boolean Algebra, Transistor Characteristics	In class	**Sub topic 1:** Boolean algebra (DE Morgan's theorems, Sum of products, product of sums (Minterm & max- terms), Boolean Function minimization (Function minimization using Karnaugh's map, Don't care conditions. **Sub topic 2:** Transistor amplifying action, Transistor as a switch, common emitter configuration, common collector configuration.	7	3	1,2	1
	**Assignment Topics	Numericals.				
Module 4: Combinatorial Circuits, Transistor Biasing and Small signal model (H-parameter model)	In class	**Sub topic 1:** Arithmetic circuits (half adder, full adder, subtractor, parallel binary adder, look ahead carry adder), Data processing circuits (Multiplexes, de-multiplexers, Decoders, encoder). **Sub topic 2:** Biasing and stabilization against variation in I_{CO}, V_{BE} and β.	7	4	1,2	1
	****Assignment Topics**	Numericals.				
Module 5: Sequential circuits, Field Effect Transistors and amplifier	In class	**Sub topic 1:** Flip flops (LATCH, SR, D and JK flip flops, truth tables and excitation tables), Shift registers, Counters. **Sub topic 2:** Characteristics of FETs, Transfer characteristics, specification, Depletion type MOSFET, Enhancement type MOSFET, Classification of amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Oscillators and feedback amplifiers.	8	5	1,2	1
	****Assignment Topics**	Numericals.				

TEXT BOOKS:

1. Millman and Halkias - Integrated Electronics: Analog and Digital circuits and systems- TMH- 1992

2. A. Anand Kumar – Fundamentals of Digital Circuits.

3. Op-amps and Linear IC's, R.A. Gayakwad, PHI.

REFERENCE BOOKS:

1. Boylestad and Nashelsky - Electronic Devices and Circuit Theory Ed. 5. -PHI, 1993.
2. M. Mirris Mano - Digital Logic and Computer Design.
3. Thomas L. Floyd – Digital Fundamentals.
4. S. Salivahanan & S. Arivazhagan – Degital Circuits and Design.
5. Donald P leach & Albert Paul Malvino-Digital Principles and Applications.

IV SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-II

EE204A3 **Credit: 4 (L-3, T-1, P-0)**

DATA BASE MANAGEMENT SYSTEMS

Questions to be set: 05(All compulsory)

Course objectives:

1. To Teach the basic database concepts, applications, data models, schemas and instances.
2. To Demonstrate the use of constraints and relational algebra operations.
3. To Describe the basics of SQL and construct queries using SQL.

Pre Requisites: Basics of computer and programming.

Course outcomes:

1. Use the basic concepts of Database Systems in Database design
2. Apply SQL queries to interact with Database
3. Design a Database using ER Modelling
4. Understand concept of Schema Refinement and Normal Forms.
5. Understand concept of transactions management, concurrency control and recovery system

Module	Topics to be covered in class	Topics	Hrs	CO	PO	PSO
Module 1	In class	INTRODUCTION: Introduction and applications of DBMS, Purpose of data base, Data, Independence, Database System architecture- Levels, Mappings, Database, users and DBA DATABASE DESIGN: Database Design Process, ER Diagrams - Entities, Attributes, Relationships, Constraints, keys, extended ER features, Generalization, Specialization, Aggregation, Conceptual design with the E-Rmodel.	6	1	1,5	1,2
	Assignment topics					
Module 2	In class	THE RELATIONAL MODEL: Introduction to the relational model, Integrity constraints over relations, Enforcing integrity constraints, Querying relational data, Logical database design: E-R to relational, Introduction to views, Destroying/altering tables and views. RELATIONAL ALGEBRA AND CALCULUS: Preliminaries, relational algebra operators, relational calculus - Tuple and domain relational calculus, expressive power of algebra and calculus.	6	2	1,5	1,2
	Assignment topics					
Module 3	In class	SQL: Basics of SQL, DDL, DML,DCL, structure – creation, alteration, defining constraints – Primary key, foreign key,	6	3	1,5	1,2

		unique, not null, check, IN operator, Functions - aggregate functions, Built-in functions – numeric, date, string functions, set operations, sub-queries, correlated sub-queries, Use of group by, having, order by, join and its types, Exist, Any, All , view and its types. transaction control commands – Commit, Rollback, Save point, cursors, stored procedures,Trigger				
	Assignment topics					
Module 4	In class	SCHEMA REFINEMENT AND NORMAL FORMS: Introduction to schema refinement, functional dependencies, reasoning about FDs. Normal forms: 1NF, 2NF, 3NF, BCNF, properties of decompositions, normalization, schema refinement in database design, case studies.	6	4	1,5	1,2
	Assignment topics					
Module 5	In class	TRANSACTIONS MANAGEMENT: Transaction concept, transaction state, implementation of atomicity and durability, concurrent executions, Serializability, recoverability, implementation of isolation, transaction definition in SQL, testing for Serializability. CONCURRENCY CONTROL AND RECOVERY SYSTEM: Concurrency control, lock based protocols, time-stamp based protocols, validation based protocols, multiple granularity. Recovery system - failure classification, storage structure, recovery and atomicity, log- based recovery, shadow paging, buffer management, failure with loss of non-volatile storage, advanced recovery techniques, remote backup systems.	6	5	1,5	1,2
	Assignment topics					

Text books:

1. Raghurama Krishnan, Johannes Gehrke , Database Management Systems, 3rd edition, Tata McGraw Hill, New Delhi,India.
2. Elmasri Navate, Fundamentals of Database Systems, Pearson Education,India.

REFERENCE BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan (2005), Database System Concepts, 5th edition, McGraw-Hill, New Delhi,India.
2. Peter Rob, Carlos Coronel (2009), Database Systems Design, Implementation and Management, 7th edition.

IV SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-II

EE205A3 **Credit: 4 (L-3, T-1, P-0)**

PROCESS CONTROL & INSTRUMENTATION

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To provide an understanding of process.
- To learn about the basic elements or building blocks of feed forward and feedback control system.
- To be able to analyze, design and evaluate PID controller.
- To provide knowledge about different final control elements.

Pre-requisites: Knowledge of basic control system, measurement and instrumentation.

Course Outcomes (CO):

CO1 Learn the basic principles & importance of process control in industrial process plants;
CO2 Apply the use of block diagrams & the mathematical basis for the design of control systems;
CO3 Learn the basics design and tune process (PID) controllers;
CO4 Construct the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants
CO5 Learn the basic of final control elements.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: The basic process control loop	In class	**Sub topic 1:** different blocks in it, how is it different from _servo' Loop. Process modelling, process equations – their limitations - general approach. **Sub topic 2**: Effect of disturbances and variation in set point in process control. **Sub topic 3:** Offset - why does it appear, analysis, how is it eliminated. Process Reaction Curves, Controllability – using: deviation reduction factors, Gain Bandwidth product, **Sub topic 4:** State controllability, Self-regulation.	8	1	1,2	1
	**Assignment Topics	Numerical on PID controller.				
Module 2: Schemes and analysis	In class	**Sub topic 1:** On-off control, Time proportional control, PI and PID Control – Ziegler – Nichols method, Cohen - Coon method and 3-C. **Sub topic 2:** Method of parameter adjustment	7	2	1,2	1
	****Assignment Topics**	Numerical on PID controller.				
Module 3: Electric Drives	In class	**Sub topic 1:** Energy Saving with adjustable Speed Drives, AC and DC Adjustable Speed **Sub topic 2:** Drives, Stepper motor Drives, Servo Drives.	6	3	1,2	1

	**Assignment Topics	Numerical on drives.				
Module 4: Final Control Element:	In class	**Sub topic 1:** Types of Actuators and Control valves, Safety and solenoid valves, Pneumatic Actuators. **Sub topic 2:** Electrical Actuators, Valve characteristics, Cv values, Valve sizing, Valve selection, cavitation, linearization, positioners	8	4	1,2	1
	****Assignment Topics**	Numerical on final control element.				
Module 5: P-I and I-P converters	In class	**Sub topic 1:** Elements of a digital control loop. Development of a control algorithm, direct digital control. **Sub topic 2:** Control of a specific plant like: Drum Level Control.	7	5	1,2	1
	****Assignment Topics**					

RECOMMENDED BOOKS:

1. D. Patranabis, Principles of Process Control, TMH, New Delhi, 2nd Ed.
2. D. P. Eckman, Automatic Process control, John Wiley, New York
3. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia
4. P. Harriott, Process control, Mc Graw Hill, New York.

IV SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-II

EE206A3 **Credit: 4 (L-3, T-1, P-0)**

Generation, Transmission and Distribution of Electrical Power

Question to be set: 05 (All Compulsory)

Course Objectives:

The aim of the course is to familiarize the student with the detailed schematic process of various generating station compromising of thermal, hydel, nuclear and gas stations. The students are also exposed to overhead transmission lines including various components like insulators, supports, conductors etc. along with the calculation of electrical parameters and performance of short, medium and long lines. The phenomena of corona and corona losses are also studied. The students are acquainted to various aspects of mechanical design of transmission lines including the concept of sag and corona loss. The student is also exposed to various types of cables, insulating materials used, constructional aspect, rating and selection of cables for 3 phase and 1 phase system.

Pre-requisites: Basic concepts of Electrical Engineering.

Course Outcome (CO)

CO1 Analyse the detailed outline of the various methods of power generation.

CO2 Optimize different mechanical parameters of transmission system

CO3 Calculate the different electrical parameters in transmission system.

CO4 Categorize the transmission system into different categories and analyse their performance.

CO5 Analyse underground transmission system in form of underground cables.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 Generation And Overview of Supply system.	In class	Concept of generation, Types of generation: Conventional and Non-conventional, various power stations understanding the concept of overhead and underground transmission and also general idea of distribution Outline of **Thermal power station**, schematic block diagram and detailed discussion i.e. cost, advantages and disadvantages, numerical Outline of **Hydel power station** with schematic block diagram and detailed discussion including cost, advantages and disadvantages, Numerical Outline of **gas power station** with schematic block diagram, detailed discussion including cost, advantages and disadvantages Outline of **nuclear power station** with schematic block diagram generation of power with non-conventional energy sources Typical AC transmission and distribution scheme, standard Voltages	10	1	1,2, 3	1

		Advantages and limitation of AC high voltage transmission, feeders distributors end service mains- effect of working voltage on feeders and distributors Related numerical Kelvin's law, merits and demerits Line Parameters: overview Calculation of inductance single phase line and three phase lines with symmetrical spacing				
	**Assignment Topic	Numerical based on different types of supply system		1	2	1
Module 2 Mechanical design:	In class	Mechanical characteristics of O.H. lines: Corona: Phenomenon - critical voltages- factors affecting corona- corona loss. Sag calculations in conductor's- level supports Sag calculations in conductor's- unequal level supports Related numerical Insulators: Types- constructional features- Potential distribution in a string of suspension	17	2	2, 3	1
	**Assignment Topic	Numerical on Sag		2	3	1
Module 3 Electrical Design	In class	Line Parameters: Calculation of inductance single phase line and three phase lines with symmetrical and unsymmetrical spacing, Line Parameters: Calculation of capacitance of single phase line and three phase lines with symmetrical and unsymmetrical spacing Transposition, GMD, GMR and their applications in the inductance and capacitance calculations.	7	3	3	1
	**Assignment Topic					
Module 4 Performance of Transmission lines	In class	Line Performance: Short lines -nominal T models, Related Numerical Medium lines -nominal T models ,Description with numerical Medium lines -nominal pi models, Description with numerical ABCD constants- Equivalent T and PI circuits	6	4	2	1
	**Assignment Topic	Numerical on short and medium transmission line				
Module 5 Underground Cable	In class	Insulating Materials used - PVC, Paper, XLPE comparison, Constructional features of cables PVC, Paper insulated, XLPE- Electrostatic stress Capacitance and insulation resistance of single core cables, Numerical Capacitance of 3- core cables. Types of cable faults	5	5	3	1
	**Assignment Topic					

RECOMMENDED BOOKS:

1. Chakraborti, Soni Gupta Bhatnagar - A Text Book of Power System Engineering – DhanpatRai& Co.
2. S.N. Singh - Electric Power Generation, Transmission & Distribution – Prentice Hall of India (PHI).
3. Nagrath and Kothari - Power System Engineering- TMH, 1994.
4. C.L. Wadhva- Electrical Power System (Ed. 2) - Wiley Eastern, 1993.
5. T.S.M. Rao - Principal and Practice of Electric Power Transfer System- Khanna,1974.

V SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-III

EE301A3 **Credit: 3 (L-2, T-1, P-0)**

LATEST TRENDS IN ELECTRICAL AND ELECTRONICS ENGINEERING

Questions to be set: 05 (All Compulsory)
Course Objectives: To learn recent advancements in various specialised fields of electrical engineering like Renewable energy, smart grid, power electronics, fuzzy control, DSP based controls and electrical machines.

Course Outcome (CO):
On successful completion of this course, students will be able to

- **CO1** Analyze the renewable energy, advanced embedded system, and their application.
- **CO2** Design the fuzzy logic for use in different engineering applications and concept of control system.
- **CO3** Illustrate the fundamentals of Neural network and concept of some advanced power converters
- **CO4** Illustrate the vector controlled induction motor using different reference frames, namely- stator, rotor and synchronous rotating reference frames.
- **CO5** Illustrate the concept of PLC and biomedical instrumentation with suitable examples

Pre-requisites: Knowledge of subjects like Control system, Power system analysis, Power electronics and Electrical Machines.

** not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: Smart Grid and Renewable Energy	In class	Storage, The need for demand response and different forms of demand response, Microgrids, Advanced Metering Infrastructure & the smart meter, Energy Efficiency programs & technology MPPT programs and technology.	7	CO1	PO1	PSO1, PSO2
	** Assignment Topics					
Module 2: Fuzzy compositional rules of inference	In class	Fuzzy compositional rules of inference-Methods of decompositions, Defuzzification. Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts, Adaptive fuzzy control, Rule base design using dynamic response. Fuzzy logic applications to engineering.	6	CO2	PO1	PSO1, PSO2
	** Assignment Topics					
Module 3: Application of Neural network and power electronics	In class	Application of Neural network: Associative memory and application, Image Processing and Restoration, Design and development using NN. Neuro fuzzy inference system: ANFIS, Structure, application and advantages.	6	CO3	PO2	PSO1, PSO2

		Resonant and soft switching techniques: Types, operation and advantages. Application of Power Electronics: Power electronics in control, renewable energy and power system.				
	** Assignment Topics					
Module 4a: Dynamic modeling of Induction machine	In class	Real time model of a two-phase induction machine, three phase to two phase transformation, Power Equivalence.	3	CO4	PO2	PSO1, PSO2
	** Assignment Topics					
Module 4b: Programming Logic Controller-Ladder programming	In class	Introduction of plc, architecture, ladder diagram and applications	4	CO5		
	** Assignment Topics					
Module 5a: Advanced Embedded system/Raspberry Pi	In class	Embedded System: System on Chip (SoC), Multi core processor, Multi language support, Use of open source technology. Raspberry Pi: Overview, Hardware – Processor, RAM, Peripherals, Specification, Connectors.	5	CO1	PO2	PSO1, PSO2
	** Assignment Topics					
Module 5b: Biomedical instrumentation	In class	Advanced Electrophysiological measurements and Medical imaging technology. (Electrocardiography, Electroencephalography, Electromyography, Electroretinography and X-RAY machine, Computer Tomography, Magnetic Resonance Imaging System, Ultra Sonography)	3	CO5		
	** Assignment Topics					
Module 5c: Control System	In class	State Space Design	3	CO2		
	** Assignment Topics					

Textbooks:

1. Electric Motor Drives: Modeling, Analysis, and Control by R. Krishnan, Pearson Education.
2. Fuzzy Logic with Engineering applications by Timothy J. Ross. Wiley 2005

Reference Books:

1. Fuzzy Logic Intelligence, Control and Information by John Yen and Reza Langari, Pearson Education; First edition 1999

V SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-III

EE302A3 **Credit: 3 (L-2,T-1,P-0)**

EHV AC AND DC TRANSMISSION

Questions to be set: 05 (All Compulsory)
Course Objectives: To learn the reason and history of EHV AC & DC power systems, significant milestones. To inculcate the understanding about the EHV AC & DC transmission together with its components and control and an introduction to FACTS.

Pre-requisites: Knowledge of power system structure and analysis methods.

Course Outcomes (CO):
CO1: Understand the aspects of EHV AC and DC transmission lines.
CO2: Calculate various parameters of EHV line.
CO3: Understand the principles and modelling of EHV DC transmission lines.
CO4: Understand the adverse effects of system harmonics and it filtration and mitigation.
CO5: Control of HVDC lines and understand the various system elements involved.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module:1	In class	Aspects of EHV AC and DC transmission. General Background and State of art of EHV AC Transmission Technology Bundled conductors, Maxwell's Coefficients, Inductance and capacitance matrices.	7	1	1,2	1
	Assignment					
Module: 2	In class	Surface Voltage gradient on bundled conductors, Mangoldt's formula, Gradient factors. Corona Effects: Power Loss, BI. Ground level electrostatic field of EHV Lines.	7	2	1,2	1
	Assignment					
Module: 3	In class	Introduction to HVDC transmission: Comparison with EHV AC power transmission, HVDC system configuration and components. Principles of AC/DC conversion: Converter connections, Wave forms, Relevant Equations.	7	3	1,2	1
	Assignment					
Module: 4	In class	Harmonics and Filters : Waveforms of a-c bus currents in Star/Star, Star/delta & 12-phase converters and their Fourier-series representations, Non-characteristic harmonics, Harmful Effects of Harmonics, DC side harmonics, Filters and detuning, Cost considerations of filters.	7	4	1,2	1
	Assignment					

Module: 5	In class	HVDC system control : Frequency Control of A.C. system, Stabilisation & damping of A.C. networks. HVDC systems elements: Converter transformers, D.C. smoothing reactors, Earth electrodes & earth return.	8	5	1,2	1
	Assignment					

Text Books:

1. R.D. Begamudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Ltd., 1986.
2. S.Rao, EHV AC and HVDC Transmission Engineering & Practice, Khanna Publishers, Delhi, 1990.
3. Reactive Power Control & Voltage Stability in EHV-AC Transmission System- A.Chakraborti, PHI

Reference Books:

1. HVDC Power Transmission Systems by K. Padiyar, Wiley Eastern Ltd.
2. EHV AC and HVDC Transmission Engineering and Practices by S.S. Rao, Khanna Publications.

V SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-III

EE303A3 **Credit: 3 (L-2, T-1, P-0)**

EMBEDDED SYSTEMS

Questions to be set: 05 (All Compulsory)

Course Objectives:

- Understand the basics of an embedded system.
- Understand the typical components of an embedded system.
- To recognize different communication interface system of Embedded system.
- To study the design process of embedded system applications.
- To realize the RTOS and inter-process communication

Pre-requisites: Knowledge of Differential Equations , and Numerical Analysis.

Course Outcomes (CO):

CO1	Comprehend the design process of an embedded system
CO2	Understand typical embedded System & its components
CO3	Be knowledgeable with different types of serial communication of micro devices.
CO4	Understand embedded firmware design approaches
CO5	To gain knowledge of basics of OS and RTOS

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: INTRODUCTION TO EMBEDDED SYSTEMS	In class	History of embedded systems, Classification of embedded systems based on generation and complexity, Purpose of embedded systems, The embedded system design process-requirements, specification, architecture design, designing hardware and software, components, system integration, Applications of embedded systems, and characteristics of embedded systems..	8	1	1,2	1
	**Assignment Topics	Introduction of embedded systems				
Module 2: TYPICAL EMBEDDED SYSTEM	In class	Core of the embedded system-general purpose and domain specific processors, ASICs, PLDs, COTs; Memory-ROM, RAM, memory according to the type of interface, memory shadowing, memory selection for embedded systems, Sensors, actuators, I/O components: seven segment LED, relay, piezo buzzer, push button switch, other sub-systems: reset circuit, brownout	8	2	1,2	1

		protection circuit, oscillator circuit real time clock, watch dog timer.				
	****Assignment Topics**	Typical embedded system design				
Module 3: COMMUNICATION INTERFACE	In class	Onboard communication interfaces-I2C, SPI, CAN, parallel interface; External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS,	8	3	1,2	1
	**Assignment Topics	Communication protocol				
Module 4: EMBEDDED FIRMWARE DESIGN AND DEVELOPMENT	In class	Embedded firmware design approaches-super loop based approach, operating system based approach; embedded firmware development languages-assembly language based development, high level language based	8	4	1,2	1
	**Assignment Topics	Firmware design				
Module 5: RTOS BASED EMBEDDED SYSTEM DESIGN	In class	Operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling: non-pre-emptive and pre-emptive scheduling; task communication-shared memory, message passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques.	8	5	1,2	1
	****Assignment Topics**	OS and ROS				

TEXTBOOKS:

1. Introduction to Embedded Systems - shibu k v, Mc Graw Hill Education.
2. Computers as Components –Wayne Wolf, Morgan Kaufmann (second edition).

REFERENCE BOOKS:

1. Embedded System Design -frank vahid, tony grivargis, john Wiley.
2. Embedded Systems- An integrated approach - Lyla b das, Pearson education 2012.
3. Embedded Systems – Raj Kamal, TMH

VI SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-IV

EE304A3 **Credit: 4 (L-3, T-1, P-0)**

ELECTRICAL DRIVES

Questions to be set: 05 (All Compulsory)

Course Objectives: This course focuses on the fundamental of electrical drives and its dynamics and control; selection of motor rating; starting, braking, transient operation, and speed control of dc motor and induction motor. This also deals with imparting education in the field of electrical machines, drives, and to some extent of power electronics. The course also emphasizes on modelling and analysis of conventional and advanced electrical drives.

Course Outcome (CO): On successful completion of this course, students will be able to

CO1	Evaluate the thermal model of electric motors and analysis the closed loop control of electric drives.
CO2	Analyze the performance characteristics of dc motor drives under steady-state and transient conditions.
CO3	Design of various drive components/systems and methods for control the speed of dc motor drives.
CO4	Analyze the performance characteristics of ac motor drives under steady-state and transient conditions.
CO5	Illustrate the vector controlled induction motor using different reference frames, namely- stator, rotor and synchronous rotating reference frames.

Pre-requisites: Understanding of basics of various types of electric motors, drive systems, and knowledge of power electronics circuits.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Electric Drives Ratings**	In class	**Sub topic 1:** Advantages of Electric drives, Factors affecting the choice of electric drives, Methods of closed loop control of drives, Selection of motor power rating, **Sub topic 2:** Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating, equivalent current, torque and power methods, short time duty, intermittent duty.	7	CO 1	PO1	PSO1, PSO2
	** Assignment Topics					
Module 2: **DC Motor Drives**	In class	Sub topic 1: Performance characteristics of dc series, shunt and compound motors, Braking - Regenerative, dynamic and plugging. **Sub topic 2:** Transient analysis of separately excited motor with armature voltage control, Starting, dynamic braking and energy loss.	8	CO 2	PO1	PSO1, PSO2
	** Assignment Topics					
Module 3:	In class	**Sub topic 1:** Armature voltage control, Flux control, Armature resistance control.	7	CO 3	PO2	PSO1, PSO2

Speed Control Of D.C. Drives		**Sub topic 2:** Methods of speed control of single phase and three phase converter fed separately excited dc motor (Block diagram approach only), Speed control of chopper fed dc motor (Block diagram approach only). **Sub topic 3**: Four quadrant dc drive.				
	** Assignment Topics					
Module 4: **AC Motor Drives**	In class	**Sub topic 1:** Induction motor drive: Performance characteristics of squirrel cage and slip ring induction motors, Braking - Regenerative, Dynamic and Plugging. **Sub topic 2:** Transient analysis - Starting and Plugging, Calculation of energy loss. Speed control - Stator voltage control, Slip power recovery, E/f, V/f and flux weakening methods.	10	CO 4	PO2	PSO1, PSO2
	** Assignment Topics					
Module 5: **Basics of Vector Control**	In class	Vector controlled induction motor drives: Introduction, principle of vector control.	4	CO 5	PO2	PSO1, PSO2
	** Assignment Topics					

Text Books:

1. Fundamentals of Electric Drives by G. K. Dubey, NAROSA, 1995.
2. Electric Motor Drives: Modeling, Analysis, and Control by R. Krishnan, Pearson Education, 2006.

Reference Books:

1. First Course on Electric Drives by S. K. Pillai, Wiley Eastern, 1990.
2. Power Electronic Control AC Motors by J.M.D. Murphy & F. G. Turnbull, Pergamon Press, 1988.

VI SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-IV

EE305A3 **Credit: 4 (L-3, T-1, P-0)**

ELECTRICAL MACHINE DESIGN

Questions to be: 05 (All Compulsory)

Course Objectives:

- To learn the principal laws of machine design.
- To learn the concept of DC machine design.
- To learn the concept of AC machine design.

Pre-requisites: Fundamental of Machines.

Course Outcomes (CO):

CO1 Knowledge on laws of machine design.
CO2 Knowledge on magnetic circuit design.
CO3 Design concept of rotating machine.
CO4 Knowledge of design process.
CO5 Design concept of insulation.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Laws in Machine Design	In class	**Sub topic 1:** Principal Laws and Methods in Electrical Machine Design - Electromagnetic Principles, Windings of Electrical Machines- Basic Principles, Salient-Pole Windings, Slot Windings.	8	1	1,2	1
	**Assignment Topics	Numerical on winding design.				
Module 2: Design of Magnetic circuit.	In class	**Sub topic 1:** Design of Magnetic Circuits- Air Gap, Core Length, Magnetic Materials of a Rotating Machine. Design of Transformers, DC machines.	6	2	1,2	1
	****Assignment Topics**	Numerical.				
Module 3: Introduction to design of rotating machines	In class	**Sub topic 1:** Main Dimensions of a Rotating Machine- Mechanical, Electrical and Magnetic Loadability, Air Gap.	10	3	1,2	1
	**Assignment Topics	Numerical.				
Module 4: Design of rotating machines	In class	**Sub topic 1:** Design Process and Properties of Rotating Electrical Machines- Asynchronous Motor, Synchronous	6	4	1,2	1
	****Assignment Topics**	Numerical.				
Module 5: Insulation design	In class	**Sub topic 1:** Machine. Insulation of Electrical Machines - Dimensioning of an Insulation. Thermal Design aspects.	6	5	1,2	1
	****Assignment Topics**	Numerical.				

RECOMMENDED BOOK:

1. Design of Rotating Electrical Machines, Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, John Wiley & Sons, Ltd.

2. A Course in Electrical Machine Design, A.K.Sawhney, Dhanpat Rai.

3. The Performance and Design of Alternating Current Machines- M. G. Say, CBS Publisher.

VI SEMESTER B.TECH. (E&E)
PROGRAM ELECTIVE-IV

EE306A3 **Credit: 4 (L-3,T-1,P-0)**

FLEXIBLE AC TRANSMISSION SYSTEM

Questions to be set: 05 (All Compulsory)

Course Objectives: To enable the students acquire a comprehensive idea of various aspects of FACTS systems. To acquire the knowledge on Flexible AC transmission system and its importance in modern power system. To understand Various FACTS Devices, their operation and applications.

Pre-requisites: Electrical power Transmission, Power Electronics, Transformers, AC power.

Course Outcomes (CO):
CO1: Conduct investigations on Transmission line with and without compensation
CO2: Understand the basics and modelling of shunt connected FACTS devices
CO3: Understand the basics and modelling of series connected FACTS devices
CO4: Understand the basics of shunt and series connected FACTS devices
CO5: Apply various FACTS devices for manipulating/controlling various Transmission line parameter and power oscillation damping

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module:1	In class	AC Transmission Line and Reactive Power Compensation: Analysis of Uncompensated AC line, Passive Reactive Power Consumption, Compensation by a Series Capacitor Connected at the Midpoint of the line, Comparison between Series and Shunt Capacitor, Compensation by STATCOM and SSSC.	8	1	1,2	1
	Assignment					
Module: 2	In class	Static Var Compensator: Analysis of SVC, Configuration of SVC, SVC Controller, Modelling of SVC, Application of SVC. Static Synchronous Compensator (STATCOM): Principle of STATCOM, analysis of STATCOM, analysis of 6-pulse VSC using switching function, multi-pulse converters, multilevel, voltage converters, harmonic transfer and resonance in VSC.	8	2	1,2	1
	Assignment					
Module: 3	In class	Thyristor and GTO Controlled Series Capacitor: Basic concepts of controlled series capacitor, Operation of TCSC, Analysis of TCSC, Control of TCSC, Modelling of TCSC for stability, GTO controlled series capacitor. Static Synchronous Series Compensator: Operation of SSSC and	8	3	1,2	1

		the control of power flow, modeling and control of SSSC.				
	Assignment					
Module: 4	In class	Unified Power Flow Controller and other Multi-Converter Devices: Operation of UPFC, control of UPFC, Protection of UPFC, Interline power flow controller, convertible static compensator.	6	4	1,2	1
	Assignment					
Module: 5	In class	Power Oscillation Damping: Basic Issues in the Damping of Low frequency Oscillations in Large Power Systems, design of damping controllers. Damping of Power oscillations using series FACTS controllers, Damping of Power oscillations using shunt FACTS controllers.	6	5	1,2	1
	Assignment					

Text Books:

1. Understanding FACTS: Concepts anf Technology of Flexible AC Transmission Systems, Narain G. Hingorani, Laszlo Gyugyi.
2. Power Electronic control in Electrical Systems: E Acha, V.G. Agelidis, O. Anaya-Lara, T.J.E Miller

Reference Books:

1. FACTS controllers in Power Transmission and Distribution, K.R.Padiyar, New Age Publication.

VI SEMESTER B.TECH. (E & E)
PROGRAM ELECTIVE-V

EE307A3 **Credit:4 (L-3, T-1, P-0)**

HIGH VOLTAGE ENGINEERING

Questions to be set: 05 (All Compulsory)

Course Objectives: Learning mechanisms of breakdown in gaseous, solid and liquid dielectrics. Learning mechanisms of high voltage measurement and testing
Pre-requisites: Basic Electrical circuits, Properties of different states.

Course Outcomes (CO):
CO1: Understand the various physical phenomena and factors that governs the breakdown of gaseous dielectric.
CO2: Understand the various physical phenomena and factors that governs the breakdown of solid dielectric and liquid dielectric.
CO3: Realise various circuits to generate high voltage and high currents for testing and measurement purposes.
CO4: Understand various circuits and methods to Measure high voltage.
CO5: Understand the methods of various testing process and apparatus in power system.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module:1	In class	Breakdown in gaseous dielectrics: Breakdown mechanism in gaseous dielectrics-Ionization and decay process – Townsend‘s criterion – Streamer mechanism of spark-Paschen‘s Law.	8	1	1,2	1
	Assignment					
Module: 2	In class	Breakdown in solid dielectrics: Intrinsic – Streamer –Thermal mechanism of breakdown. Breakdown in liquid dielectrics: Thermal Suspended particle mechanism of breakdown.	7	2	1,2	1
	Assignment					
Module: 3	In class	Generation of High Voltages and Currents. Alternating Voltage: Transformers in Cascade – Series resonant circuit – Resonant transformer. Transient Voltage: Single stage and multi stage impulse generators. Direct Voltages: Voltage doubler and multiplier circuits – Van-de-Graff Generator. Impulse Current Generator.	7	3	1,2	1
	Assignment					
Module: 4	In class	High Voltage Measurement: Measurement of AC, DC and impulse voltages and current.	7	4	1,2	1

		Series impedance voltmeters- Generating voltmeter – Electrostatic voltmeters – Potential Dividers – Capacitance voltage transformer – sphere gap.				
	Assignment					
Module: 5	In class	High Voltage Testing: Testing of Insulators – Power Transformers – Circuit Breakers – Surge deviators – cables – Bushings and Transformer oil – Schering Bridge for loss tangent measurement.	7	5	1,2	1
	Assignment					

Text Books:

1. Kamaraj & Naidu – High Voltage Engineering – TMH, 1996
2. C.L.Wadhwa – High Voltage Engineering – Wiley Easterna Ltd., 1994

Reference Books:

1. Kuffel and Abdulla – High Voltage Engineering – Pergomon, 1981.
2. R.S.Jha – A Course in High Voltage Engineering – Dhanpat Rai, 1981.

VI SEMESTER B.TECH. (E & E)
PROGRAM ELECTIVE-V

EE308A3 **Credit:4 (L-3, T-1, P-0)**

DIGITAL SIGNAL PROCESSING

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To provide an introduction to digital signal processing and its significance.
- Study the process of obtaining digital signals from analog signals
- Understand various signal processing operations on discrete time signals.
- Study time domain and frequency domain representations of discrete time systems.
- To understand digital filters and their designing process.

Pre-requisites: Basics of signals and systems.

Course Outcomes (CO):

CO1	Develop a fundamental understanding of digital signal processing and time domain analysis of discrete time systems.
CO2	Apply discrete Fourier transform for analysis of discrete time signals and systems.
CO3	Apply z-transform for analysis of discrete time signals and systems.
CO4	Design FIR digital filters.
CO5	Design IIR digital filters.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Introduction to digital signal processing and time domain analysis of discrete time systems.	In class	**Sub topic 1:** Definition, importance, classification and applications of signal processing. Introduction to digital signal processing, its basic elements, advantages and drawbacks. **Sub topic 2:** Conversion of analog to digital signal and sampling theorem. **Sub topic 3:** Time domain Analysis of Discrete-time system:- (Output response of Discrete-Time LTI System, Linear Convolution, stability of Discrete-time LTI system, Correlation of Discrete-Time Signals)	7	1	1,2	1
	**Assignment Topics	**Review of signals and systems:** Definition and classification of signals and systems, Elementary discrete time signals and basic operations on signals.				
Module 2: Discrete-Fourier Transform.	In class	**Sub topic 1:** Discrete Fourier transform (DFT) , relation with Discrete time Fourier Transform (DTFT) **Sub topic 2:** Inverse DFT. **Sub topic 3:** Fast Fourier Transform (FFT).	7	2	1,2	1
	****Assignment Topics**	Properties of DFT and related numerical.				
Module 3: Z-transform	In class	**Sub topic 1:** Z-Transform (definition and its relation with DTFT), Existence of z-transform and region of convergence. **Sub topic 2**: Inverse Z-transform.	7	3	1,2	1

	**Assignment Topics	Properties of Z-transform				
Module 4: Introduction to Digital Filters and FIR filter design.	In class	**Sub topic 1:** Definition & classification of digital filters (FIR and IIR digital filters), ideal and practical filter characteristics. **Sub topic 2:** FIR filter Design using Fourier method. **Sub topic 3:** FIR filter designing using and windowing method. **Sub topic 4:** Basic FIR digital filter structures.	7	4	1,2	1
	****Assignment Topics**					
Module 5: IIR Digital Filter Design	In class	**Sub topic 1:** Introduction to IIR filter design, Analog low pass Butterworth filter/Chebyschev filter characteristics. **Sub topic 2 :** Frequency transformation in analog domain (analog low pass to high pass, band pass and band stop). **Sub topic 3:** Frequency transformation from analog to digital domain: Impulse invariant transformation (IIT) method/bilinear transformation). **Sub topic 4:** Basic IIR Digital filter structures.	8	5	1,2	1
	****Assignment Topics**					

RECOMMENDED BOOKS:

1. Digital Signal Processing – John Prokais
2. Digital Signal Processing – Sanjit. K. Mitra
3. Digital Signal Processing – Ramesh Babu , SCI Tech Publishers

VI SEMESTER B.TECH. (E & E)
PROGRAM ELECTIVE-V

EE309A3 **Credit:4 (L-3, T-1, P-0)**

MODERN POWER CONVERTERS

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To introduce various power conversion processes or techniques.
- To provide an understanding of various power converters and power semiconductor devices, their control, protection aspects and application.
- To expose students to various DC-DC, AC-DC and DC-AC topologies of the power converters.
- To analyze various modulation techniques applicable for DC-AC power converters.

Pre-requisites: Understanding of basic electrical and electronic devices such as diodes, transistors, MOSFETs, thyristor, IGBT, inductors, capacitors, resistors etc. Knowledge of power electronics.

Course Outcomes (CO):

CO1 Design and analysis of non-isolated DC-DC converter in continuous and discontinuous conduction mode with ideal and non-ideal conditions.

CO2 Design and analysis of isolated DC-DC converter.

CO3 Design and analysis of resonant converters.

CO4 Design and analysis of resonant converters and analysis of pulse width modulation (PWM) technique.

CO5 Analysis of sine pulse width modulation (SPWM), space vector modulation (SVM), selective harmonic elimination (SHE) and hysteresis modulation techniques applicable for DC-AC converters.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Non-isolated DC-DC converter	In class	Generalized comparison between switched mode and linear DC regulator; Operation and steady state performance of Buck, Boost, Buck-Boost and Cuk Converters in continuous-conduction mode, discontinuous-mode and boundary between continuous and discontinuous mode of operation; Output voltage ripple calculation; Effect of parasitic elements.	6	1		
	**Assignment Topics					
Module 2: Isolated DC-DC converter	In class	Fly back converters and its topologies; Forward converters - Switching transition; Push-pull converterSwitching transition, limitation of the push-pull circuit.	6	2		
	****Assignment Topics**					
Module 3: Resonant converters	In class	Introduction and classification; Load resonant - series and parallel loaded converters in continuous and discontinuous mode of operation; Hybrid resonant DC-DC	6	3		

		converters; zero current switch (ZCS); zero voltage switch(ZVS); ZCS- clamped voltage converters(ZCS-CV).				
	**Assignment Topics					
Module 4: DC-AC converters	In class	Voltage source and current source inverter; single-phase and three-phase bridge inverters; square wave operation, 120 and 180 degree modes; potential diagrams.	6	4		
	****Assignment Topics**					
Module 5: Modulation techniques	In class	Current regulated (Hysteresis) Modulation; Selective harmonic elimination; sine triangular modulation; linear modulation; over modulation; harmonics in the output voltage, stair case PWM, space vector modulator.	6	5		
	****Assignment Topics**					

Recommended Books:

1. Mohan, Undeland, Robbins_Power Electronics: Converters, Application and Design, John Wiley &
sons, 1989
2. A.I. pressman- Switching mode power supply design-MGH, 1992
3. M.H. Rashid- Power Electronics, PHI, 2004

ELECTRICAL & ELECTRONICS ENGINEERING

(OPEN ELECTIVES)

III SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-I

EE 201A2 **Credit: 4 (L-3, T-1, P-0)**

ANALOG SYSTEM DESIGN

Questions to be set: 05 (All Compulsory)

Course Objectives:

- The course addresses mainly about Op-amps. The behavior of Op-amp to voltage and current.
- It is of interest to understand how the Op-amps work. How Op-amp can be used for various applications.
- Understanding of the need for feedback in case of Op-amp applications and use.
- Study different property Op-amp because of which is advantageous.
- We will learn how to design amplifiers. Different types of amplifiers with their properties will be studied.
- IC- 555timer use for the design and implementation in various projects.

Pre-requisites: Knowledge of basic electronics.

Course Outcomes (CO):

CO1 Fundamental principle of semiconductor devices
CO2 Analysis and design of electronic devices and circuits
CO3 Different types of amplifiers and their operation
CO4 Elucidate and design the linear and non-linear applications of an opamp and special application ICs.
CO5 Explain and compare the working of multivibrators using special application IC 555 and general purpose Opamp.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Op-amp architecture	In class	**Sub topic 1:**Operation -amplifier architecture, two-stage architecture, gain stage with active load **Sub topic 2**: Small signal model the differential stage, and D.C. level shifting **Sub topic 3:**current mirror, offset voltage current and CMRR frequency response.	7	1	1,2	1
	**Assignment Topics	Numerical on op-amp.				
Module 2: Basics of Op-amp	In class	**Sub topic 1:** Compensation, bandwidth consideration, offset voltage and current and slew rate limitations **Sub topic 2:** Feedback amplifiers: Classification, concepts, feedback amplifier topologies. Properties of negative feedback amplifier.	6	2	1,2	1
	****Assignment Topics**					

Module 3: Types of Op-amp, Properties and advantages of feedback amplifier	In class	**Sub topic 1:**Classifications: voltage series, voltage shunt, current series, current shunt. Properties of negative feedback amplifiers, effect of feedback on R_i, R_o and bandwidth. Advantages of negative feedback. **Sub topic 2:**Oscillators: R-C, phase-shift, Wein Bridge using op amp, crystal oscillators.	6	3	1,2	1
	**Assignment Topics					
Module 4: Subject Coordinator Applications of Op-amp	In class	**Sub topic 1:**OPAMP applications: inverting, non-inverting amplifier, voltage follower, integrator, differentiator, summing amplifier. **Sub topic 2:**Differential amplifier, phase shifter, voltage to current converter, active filters-low pass, high pass, band pass, band reject and all pass filters. (Butterworth) **Sub topic 3:**Non-linear applications of OPAMPS: comparator, Schmitt Trigger, Stable multivibrator, Monostablemultivibrator. **Sub topic 4:**Triangular wave generator, precision rectifier, Peak detector, Zero crossing detector, square wave generator, Ramp generator, V/f and f/V.	10	4	1,2	1
	****Assignment Topics**					
Module 5: IC- 555 timer construction, use and applications	In class	**Sub topic 1:**linear IC- 555 Timer, architecture, applications, Astablemultivibrator, **Sub topic 2:**Monostablemultivibrator, Schmitt trigger ramp generator. Phase locked loops, voltage controlled oscillators	7	5	1,2	1
	****Assignment Topics**	Shift counters and Mod-X counters.				

RECOMMENDED BOOKS:

1. Jacob Millman and Arvin Grabel-Micro Electronics (Ed.2)-MGH,1988.
2. Ramakant Gayakwad- OP Amps and Linear Integrated Circuits (ED.2)-PHI, 1992.
3. Sergio Franko- Design with Operational Amplifiers and Analog Integrated Circuits-MGH,1988.
4. Robert F. Coughlin and Frederick S. Driscoll- Operational Amplifiers and Linear Integrated Circuits (Ed.3)-PHI, 1987.
5. Sedra and Smith- MicroElectronics Circuits (ED.2) -Holt Rinehart & Winston, 1987.

III SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-I

EE 202A2 **Credit: 4 (L-3, T-1, P-0)**

DATA COMMUNICATION AND COMPUTER NETWORKS

Questions to be set: 05(All compulsory)

Course objectives:

1. To teach basic concepts of digital communication and networks and encryption techniques.
2. To demonstrate the various error detection and correction techniques, .
3. To Describe the basics of modern computer network, models and topology.

Pre Requisites: Basics of computer knowledge.

Course outcomes(CO):

CO1: Analyse the functioning of data communication and computer network.
CO2: Various methods of conversion such as digital to analog, analog to digital.
CO3: Analyse the transmission errors, detection and correction techniques.
CO4: Utilization of various TCP/IP services and other models.
CO5: Cryptography techniques and its applications should be taught which is very useful for security purpose.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered in class	Topics	Hrs	CO	PO	PSO
Module 1	In class	Data communication Transmitter, Receiver, Modes of Communication (Simplex, Half duplex, Full Duplex). Modulation techniques for digital communication	6	1	1,5	1,2
	**Assignment topics					
Module 2	In class	Encryption, Decryption, Ceasers cipher,playfair cipher, Symmetric key cryptography, public key cryptography, DES system, AES system	6	1	1,5	1,2
	**Assignment topics					
Module 3	In class	Types of Errors: Single Bit Error and Burst Error, Redundancy CRC Error Correction: Forward error Correction, Flow error control. . Single Bit Error Correction, Hamming Code, Brust Error Correction Data Link Control	6	2	1,5	1,2
	**Assignment topics					
Module 4	In class	Fundamental Of Computer Network: Definition And Need Of Computer	6	3	1,5	1,2

		Network, Applications,Network Benefits. Classification Of Network: LAN,WAN,MAN Client Server Network				
	**Assignment topics					
Module 5	In class	OSI Reference Model: Layered Architecture , Peer-to- Peer Processes-Interfaces between Layer, Protocols, Organization of the Layers, Encapsulation Layers of the OSI Reference Model (Functions and features of each Layer) — Physical Layer, Data-Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer,5.2 TCP/IP Model: Layered Architecture, Data Link Layer	6	4	1,5	1,2
	**Assignment topics					
Module 6	In class	**Symmetric Key Cryptography:** Traditional Ciphers, Block Cipher. **Public Key Cryptography:** Choosing public and private keys **Message Security:** Privacy, Message Authentication, Integrity, Nonrepudiation **Digital Signature:** Signing the whole document, Signing the digest.	6	5	1,5	1,2
	**Assignment topics					

Text books:

1. Data and Computer Communication| By Pearson, Pearson Education; Tenth edition (20 September 2017)
2. Data Communications and Networking | 5th Edition, by Forouzan McGraw Hill Education; Fifth edition (1 July 2017)

REFERENCE BOOKS:

1. Cryptography and Network Security - Principles and Practice | Seventh Edition | By Pearson Paperback – 30 June 2017 by Stallings William (Author)
2. Computer Networking – A top down approach featuring the Internet| By Pearson Paperback – 30 June 2017 by Kurose James F. (Author), Ross Keith W. (Author)

IV SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-II

EE205A2 **Credit: 4 (L-3, T-1, P-0)**

PRINCIPLES OF COMMUNICATION

Questions to be set: 05(All compulsory)
Course objectives: To understand the basic elements of a communication system. Study various modulation operations involved in communication. To study different types of networks and their application.

Pre Requisites: Basics of continuous signals and their equations.
Course Outcome (CO)

CO1	Fundamentals of analog communication technology
CO2	Explain different amplitude modulation techniques and characteristics
CO3	Explain different frequency-angle modulation techniques and characteristics.
CO4	Illustrate different digital-analog conversion communications techniques.
CO5	Illustrate different protocols of computer communications.

**not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered in class	Topics	Hrs	CO	PO	PSO
Module 1	In class	Elements of a general communication system**.** Frequency Translation and its need. Definition of noise and its types	6	1	1,5	1,2
	**Assignment topics					
Module 2	In class	Amplitude Modulation:- its generation and detection. Suppressed Carrier Modulation:- (DSB-SC, SSB-SC, VSB-SC). Frequency division Multiplexing. Angle Modulation:- Phase and Frequency modulation, generation and detection of FM Signal (NBFM and WBFM). Pre-emphasis and De-emphasis Circuits.	6	2	1,5	1,2
	**Assignment topics					
Module 3	In class	Analog Pulse Modulation: - PAM, PWM, PPM, TDM. Pulse Code Modulation.	6	3	1,5	1,2
	**Assignment topics					
Module 4	In class	Binary communication: ASK, FSK, PSK, detection of binary signals. Multi symbol signaling, Quadrature Amplitude modulation (QAM)	6	4	1,5	1,2
	**Assignment topics					
Module 5	In class	Introduction to data communication and networking, characteristics of a good network. *Network Topology:-*	6	5	1,5	1,2

		Bus, Tree, Ring, star, mesh (Advantages and disadvantages) *Types of Network:-* LAM, Man, WAN (Advantages and disadvantages) *OSI Model Architecture:-* Function of Layers, Physical Layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer, TCP/IP protocol Suite.				
	**Assignment topics					

Text Books:

1. Communication Systems, 4ed Paperback – 2006, Wiley; Fourth edition by Simon Haykin

2. Modern Digital And Analog Communication Systems: Fourth Edition Paperback – 1 July 2017 by B.P. Lathi (Author), Zhi Ding (Author), Hari Mohan Gupta

Reference Books:

3. Communication Systems (Analog and Digital) ,: S.K. Kataria & Sons; 2013 edition by Sanjay Sharma

4. Digital & Analog Communication Systems, 8e Paperback – 1 January 2013 by Couch (Author)

IV SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-II

EE206A2 **Credit: 4 (L-3, T-1, P-0)**

SOFTWARE ENGINEERING

Questions to be set: 05 (All Compulsory)

Course Objectives: To learn fundamentals of software engineering, life cycle, project management, design and analysis. Coding, testing reliability of software design.
Pre-requisites: Basic programming languages and computer architecture.

Course Outcomes (CO): On successful completion of this course, students will be able to

CO1 Analyze software life cycle and software project management.
CO2 Design software according to requirement and specification.
CO3 Develop OOP based software.
CO4 Design and test software using different quality management tool.
CO5 Perform maintenance of software

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (Software life cycle and project management)	In Class	Emergence of software engineering, Notable change in software development practice, Classical Waterfall Model, Iterative Waterfall Model, Comparison of different Life Cycle Models, Responsibilities of Software project manager, project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO-a Heuristic estimation techniques	7	1		
	Assignment Topics					
Module 2 (Design of software according to requirement)	In Class	Requirement gathering and analysis, software requirement specification (SRS), Formal system development techniques, Axiomatic specification, Algebraic specification, What is a good software design, Cohession and coupling, next arrangement, software design approachs Object oriented vs. functional oriented design	8	2		
	Assignment Topics					
Module 3 (Object Oriented Programming based software development)	In Class	Design pattern, A generalized object oriented analysis and design, examples, OOD goodness criteria.	7	3		
	Assignment Topics					
Module 4	In Class	Code review, Testing, Testing in the large vs testing in the small, unit	7	4		

(Software testing)		testing, Black box testing, Debugging, program analysis tool Integration testing, system testing, Software reliability, Statistical testing, software quality management system, Six sigma				
	Assignment Topics					
Module5 (Software maintenance)	In Class	CASE and its scope, CASE environment, CASE support in software life cycle, Other characteristics of CASE tools, Architecture of CASE environment, Characteristics of software maintenance, software maintenance process model	7	5		
	Assignment Topics					

RECOMMENDED BOOKS:

1. Fundamentals of software engineering by Rajib Mall PHI Publications
2. An Engineering approach to software engineering by Jalot Pankaj, Narosa Publication
3. Object oriented software engineering by Jacobson I , Addison Wesley Publication.

IV SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-II

EE207A2 **Credit: 4 (L-3, T-1, P-0)**

FUZZY LOGIC AND EVOLUTIONARY ALGORITHM

Questions to be set: 05 (All Compulsory)

Course Objectives:

- The course addresses about Fuzzy logic concepts. Algebraic and logic operations on fuzzy sets. Semiconductor devices.
- Design of fuzzy membership functions and rule-based system. Defuzzification techniques. Comparison and evaluation of defuzzification methods. It is of interest to understand how the fuzzy sets could be used for various applications.
- Understanding of the need for stability analysis of fuzzy based control system.
- An understanding of Genetic algorithms its working principle and application. Difference and similarities between GA and other traditional methods.
- Learning various application-based optimization techniques.

Pre-requisites: Knowledge of Matlab.

Course Outcomes (CO):

CO1 Comprehend the fuzzy logic control and adaptive fuzzy logic.

CO2 Identify and describe Fuzzy Logic and Artificial Neural Network techniques in building intelligent machines.

CO3 Apply Artificial Neural Network & Fuzzy Logic models to handle uncertainty and solve engineering problems.

CO4 Recognize the feasibility of applying a Neuro-Fuzzy model for a particular problem.

CO5 Integrate neural network and fuzzy logic to extend the capabilities for efficient and effective problem solving methodologies.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Fuzzy sets , fuzzy relation and membership functions	In class	**Sub topic 1**: Definitions of classical & Fuzzy set, Representation of fuzzy sets, fuzzy measure, cardinality of a fuzzy set,α-cuts, normalised fuzzy set, height of a fuzzy set, Basic set theory operations on fuzzy set, Algebraic operations on fuzzy set, Logical operations on fuzzy set. Fuzzy relations, operations on fuzzy relations, Fuzzy Cartesian product and composition, equivalence relation, binary relation on fuzzy sets, properties. **Sub topic 2:** Features of membership function, Fuzzification, Membership function shapes, assignment of membership function to fuzzy variables, evaluation of membership function	2	1	1,2	1
	**Assignment Topics	Numerical				
Module 2: Fuzzy Logic and Fuzzy rule based system	In class	**Sub topic 1**: Tautologies, Contradiction, equivalence, logical proofs, fuzzy logic, approximate reasoning **Sub topic 2**: introduction, Natural language, Design of fuzzy membership function, design of predicates, rule based system, formation of control rules	9	2	1,2	1

	****Assignment Topics**	Numerical				
Module 3: Fuzzy to crisp conversion, Fuzzy model and control systems	In class	**Sub topic 1:** Defuzzification techniques, Lambda cuts, defuzzification methods-application, comparison and evaluation of defuzzification methods **Sub topic 2:** Fuzzy models, structured fuzzy models, stability analysis of fuzzy model based control system, case studies (classification of equivalence relations, fuzzy classification, fuzzy pattern recognition, multifeatured pattern recognition)	9	3	1,2	1
	**Assignment Topics	Numerical				
Module 4: Fundamentals of Genetic algorithm and Genetic modeling	In class	**Sub topic 1:** Basic concepts, Creation of Off springs, Working Principle. **Sub topic 2:** Encoding, Fitness Function, Reproduction **Sub topic 3:** Inheritance Operators, Cross Over, Inversion and Deletion, Mutation Operator, Bit-wise Operator, bit-wise operator used in GA, generational cycle, convergence of Genetic Algorithm **Sub topic 4:** Application, Multi-Level Optimization, Differences and Similarities between GA and Other traditional Method	8	4	1,2	1
	****Assignment Topics**	Numerical				
Module 5: Fuzzy logic controlled genetic algorithms, advanced optimization techniques, Application of fuzzy logic and genetic algorithms	In class	**Sub topic 1:** Soft computing tools, Problem description of optimum design, Fuzzy constrains, Illustrations, GA in Fuzzy Logic Controller Design, Fuzzy logic controller, FLC-GA based structural Optimization. Identification of dynamic system model with G.A, familiarization of F.L. & G.A Toolbox of MATLAB. **Sub topic 2:** Basic concept of Ant colony optimization, particle swarm optimization, Tabu search optimization method, difference between PSO&GA. At least TWO applications of Fuzzy logic and Genetic Algorithms in detail are to be taught.	8	5	1,2	1
	****Assignment Topics**	Numerical				

RECOMMENDED BOOKS:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms Synthesis and Application by S. Rajasekaran , G.A. Vijayalakshmi Pai. PHI 2003.
2. Fuzzy Logic with Engineering applications by Timothy J. Ross. Wiley, 2005
3. Neural Network Design: Martin T Hagon, Howard B Demuth Mark Beale, Thomson learning 2005.

V SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-III

EE301A2 **Credit:4 (L-3, T-1, P-0)**

RENEWABLE ENERGY SYSTEMS

Questions to be set: 05 (All Compulsory)

Course Objectives:

To impart the basic knowledge about the renewable energy sources. To inculcate the understanding about the fundamentals of solar energy. To understand the working of wind energy.

Course Outcomes(CO):

After successful completion of this course, students will be able to:

CO1 Analyze and evaluate fundamental aspects of renewable energy resources, their uses, applications and limitations.
CO2 Concepts in solving numerical problems pertaining to solar radiation geometry, solar thermal system and solar photovoltaic cell.
CO3 Explore the concepts involved in wind energy conversion system and hdro power by studying its components, types and performance.
CO4 Illustrate ocean energy and explain the operational methods of their utilization.
CO5 Familiarization with hybrid energy systems to meet the future energy demand.

** not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Introduction to Renewable energy**	in class	Classification, comparison of conventional fossil fuel and non-conventional energy sources. Problems with fossil fuels, possible solution.	2	1		
	****Assignment Topics**	Renewable energy utilization in ancient times		1		
Module 2: **Solar Radiation geometry, Solar thermal energy and Solar PV system**	in class	Basic of solar energy. Solar thermal energy conversion techniques. Applications of solar thermal technologies, Basic principles of solar PV technology, working principle, applications, problems, MPPT techniques	14	2		
	****Assignment Topics**	Practice problem based on solar energy.		2		
Module 3: **Wind energy conversion system and Hydel Energy**	in class	Basic principle of WECS, techniques, application, problems and MPPT, Hydel energy conversion technique. Operation and principle.	10	3		
	****Assignment Topics**	Practice problem based on wind energy and hydro power.		3		
Module 4: **Tidal energy and OTEC**	in class	Operation, principle and application. Problems with tidal energy and possible solution, Operation, principle and application. Problems with OTEC energy and possible solution.	7	4		

	****Assignment Topics**	Problems related to ocean energy.		4		
Module 5: **Application and recent advancement**	in class	Micro grid, electric vehicle, hybrid energy systems.	4	5		
	****Assignment Topics**	Micro grid integration techniques.		5		

1. **Text Books:** G D Rai, "Non- Conventional Energy Sources", Khanna Publishers

2. **Reference Books:**
   Non-conventional energy resources by "Dr. B. H. Khan".

V SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-III

EE302A2 **Credit:4 (L-3, T-1, P-0)**

WAVE GUIDES AND ANTENNA

Questions to be set: 05 (All Compulsory)
Course Objectives: This course delves into the processes of waves and antenna to provide the basic foundation in communication. All detailed basics required are covered.

Pre-requisites: Basic knowledge of communication.

Course Outcomes (CO): On successful completion of this course, students will be able to

CO1 Apply and analyze Transverse Magnetic and Electric waves in Rectangular Guides
CO2 Analyse the interaction of Fields and Matter and Space-Charge-Limited Diode
CO3 Analyse Potential functions and the electromagnetic field
CO4 Analyse Antenna Fundamentals
CO5 Design and analyse Antenna Array

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (Transverse Magnetic and Electric waves)	In Class	Transverse Magnetic and Electric waves in Rectangular Guides, Impossibility of TEM Wave in Wave guides, Solution of the field Equations, TM and TE Waves in Circular Guides, Wave Impedances and characteristic Impedances, Transmission Line Analogy for wave Guides, Attenuation factor and Q of Wave Guides. Dielectric slab wave Guides.	8	1		
	Assignment Topics					
Module 2 (Interaction of Fields and Matter and Space-Charge-Limited Diode)	In Class	Interaction of Fields and Matter , Space-Charge-Limited Diode, Plasma Oscillations, Wave propagation in a plasma, Polarization of Dielectric Materials, Equivalent volume and surface charges, the permittivity concept, Magnetic Polarization, Equivalent Volume and surface currents, The permeability concept, Frequency response of Dielectric Material.	7	2		
	Assignment Topics					
Module 3 (Potential functions and the electromagnetic field)	In Class	Potential functions and the electromagnetic field. Potential function‘s for Sinusoidal Oscillation. The alternating current element, Power Radiated by a current element, Application to short Antennas. Assumed current distribution, Radiation from a Quarter-Wave	7	3		

		Monopole or Half-Wave Dipole. Sine Integral and Cosine Integral, Electromagnetic field close to an antenna, Solution of Potential Equations far field Approximation.				
	Assignment Topics					
Module 4 (Antenna Fundamentals)	In Class	Antenna Fundamentals.	7	4		
	Assignment Topics					
Module 5 (Antenna Arrays)	In Class	Antenna Arrays.	7	5		
	Assignment Topics					

Text Books:

1. C.A. Balanis ,*AntennaTheory: Analysis and Design*, 4th Edition,Wiley Publishers, Jan 2016.
2. J.D. Kraus,Ronald J Marhefka and Ahmad S Khan, *Antennas for all Applications*, Tata McGraw Hill Publishing Co. Ltd., 3rd edition 2008.
3. *Microstrip patch antennas: A Designer's guide*, Springer, 1st edition, 2003.

Reference Books:

1. R.E. Collin, *Antennas and Radio Wave Propagation*, 1e , McGraw Hill Book Co, 1985.
2. KD Prasad, Antenna *and wave propagation*, 3e, Satya Prakashan, 2005.
3. Ramesh. Garg, Prakash Bhartia, InderBahl and ApisakIttipiboon, *Microstrip Antenna Design Handbook*, Artech House Publishers, 2000

V SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-III

EE303A2 **Credit:4 (L-3, T-1, P-0)**

VLSI DESIGN

Questions to be set: 05 (All Compulsory)
Course Objectives: This course delves into the processes of VLSI to provide the basic foundation in circuitry design. All detailed basics required are covered.

Pre-requisites: Knowledge of analog and digital electronic circuits.

Course Outcomes (CO): On successful completion of this course, students will be able to

- **CO1** Apply and analyze MOS transistor in circuit model
- **CO2** Design MOS circuit and its layout diagram.
- **CO3** Design BiCMOS technology, circuits and Logic Synthesis.
- **CO4** Design of an ALU Subsystem, Memory, Registers and analyse aspects of system timing
- **CO5** Analyse practical aspects, testability and synthesis of FPGA.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (MOS transistor)	In Class	Introduction to VLSI Systems, MOS Transistor – Current versus voltage relationships, Threshold voltage, Pass transistor, Transmission gate, Basic DC equations, nMOS inverter, MOS transistor circuit model, BiCMOS inverter, Steered input to an nMOS inverter, Depletion mode and enhancement mode pull ups, CMOS inverter, Latch up in CMOS circuits, BiCMOS Latch up susceptibility.	8	1		
	Assignment Topics					
Module 2 (MOS circuit design process)	In Class	Stick diagram, Design rules and layout, Layout diagram, Symbolic diagram. Scaling models and scaling factors, scaling factors for device parameters, Limitation of scaling. Subsystem Design and Layout – Switch logic, Gate logic, Combinational Logic, Clocked sequential circuits	7	2		
	Assignment Topics					
Module 3 (BiCMOS technology, circuits and Logic Synthesis)	In Class	Introduction to BiCMOS technology, BiCMOS technology, Bipolar logic, BiCMOS logic circuits, Complex logic using BiCMOS, Application, Disadvantage. Introduction to Logic Synthesis, Transistor level synthesis, Logic level synthesis, Block level synthesis, Algorithm, Boolean space, Binary Decision Diagram (BDD), Advantage, Disadvantage.	7	3		
	Assignment Topics					

Module 4 (Design process and Memory, Registers and aspects of system timing)	In Class	Regularity, Design of an ALU Subsystem, 4 bit adder, Manchester Carry-chain, adder enhancement techniques, Multipliers. System timing considerations, Commonly used storage/memory elements, Forming arrays of memory cells.	7	4		
	Assignment Topics					
Module 5 (Practical aspects and testability and FPGA)	In Class	Optimization of nMOS and CMOS inverters, Floor plans/Layout, System delays, Test and Testability. Introduction to FPGA, Features, Architecture, Basic unit of FPGA, Synthesis, Time, area and power analysis.	7	5		
	Assignment Topics					

RECOMMENDED BOOKS:

1. Douglas A. Pucknell, Kamran Eshraghian, Basic VLSI Design, Third Edition, PHI Learing Pvt. Ltd., New Delhi
2. Debaprasad Das – VLSI Design, Third Edition, Oxford University Press.
3. Sung-Mo (Steve) Kang, Yusuf Leblebici – CMOS Digital Integrated Circuits: Analysis and Design, Third Edition, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

VI SEMESTER B.TECH. (E & E)
OPEN ELECTIVE-IV

EE305A2 **Credit: 4 (L-3, T-1, P-0)**

ADVANCED METHODS IN CONTROL THEORY

Questions to be set: 05 (All Compulsory)
Course Objectives: The objective of this course is to gain the knowledge of control system in engineering applications. To learn about state apace analysis of system. To design observer of a system depending on the availability and measurability of different feedback states. Design a controller for a system using optimal control.
Pre-requisites: Knowledge of Linear Control System.

Course Outcomes (CO): On successful completion of this course, students will be able to

- **CO1** Apply and analyze linear algebra, vector space.
- **CO2** Design a controller using pole placement, state feedback and observer for a system.
- **CO3** Design a controller for a system using robust control.
- **CO4** Design a controller for a system using H-infinity control and apply the concept of calculus of variation in control problems.
- **CO5** Design a controller for a system using optimal control.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (Linear Algebra)	In Class	Introduction to Vector Spaces, Vector Spaces, Linear Independence, Basis, Linear Transformations, Projections, Orthogonal / Orthonormal Bases, Gram-Schmidt orthogonalization. Singular value Decomposition (SVD), LQR Factorization.	7	1		
	Assignment Topics					
Module 2 (State Space Design)	In Class	Introduction to State Space design, Concept of State, State vector, state space, State models of electrical systems, System description, pole placement design using state feedback, tracking problem, observer design, introduction to reduced order observer. MATLAB implementation	8	2		
	Assignment Topics					
Module 3 (Robust Control)	In Class	Introduction to Robust control theory, Elements of Robust control theory, Design objectives and specifications, shaping the loop gain. Structured and unstructured uncertainty, internal stability, small gain theorem, sensitivity and complementary sensitivity function. LFT (Linear Fractional Transformation) technique.	8	3		
	Assignment Topics					
Module 4	In Class	Problem formulation, output feedback, full state information control, disturbance feed	7	4		

(H∞ control and Calculus of Variations)		forward, output estimation, separation theory and controller interpretation. H∞ loop shaping design procedure. Fundamental concepts. Functional of single function - Euler - equation-General variation of a functional-Functionals of several independent functions- Boundary conditions. Variational approach to optimal control.				
	Assignment Topics					
Module 5 (Linear Quadratic Optimal Control)	In Class	Problem formulation, Finite time linear quadratic regulator, Infinite time LQR. LQR tracking system. Kalman Filtering.	6	5		
	Assignment Topics					

Books:

1. Modern control engineering, Book by Katsuhiko Ogata

2. Modern Control Theory, by K.R. Verma

VI SEMESTER B.TECH. (E & E)
OPEN ELECTIVE-IV

EE306A2 **Credit: 4 (L-3, T-1, P-0)**

MACHINE LEARNING

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To introduce the student with the broad outlines of machine learning.
- To familiarize students with various techniques of machine learning used to classify, categorize and interpret data.

Pre-requisites: Knowledge of any programming language.

Course Outcomes (CO): On successful completion of this course, students will be able to

CO1 Explain the application of machine learning, the general step wise process to machine learning and different methods of learning.
CO2 Categorize the data based on gain using decision tree.
CO3 Explain the use of instance based learning, linear regression, logistic regression and support vector machines to segregate the data
CO4 Analyse artificial neural network model and its advance version as deep learning
CO5 Distinguish between different types of clustering techniques.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (Introduction, Types of learning)	In Class	Overview: Foundations, Scope, Problems, Approaches of AI, Applications, Types of learning and types of error, k-fold validation	8	1	1	1
	Assignment Topics					
Module 2 (Intelligent Agents, Decision tree)	In Class	Hypothesis, bias, features, Decision tree, Calculation of gain, entropy, Classification of data based on decision tree, Prunning-pre-prunning, post prunning	4	2	2	1
	Assignment Topics					
Module 3 Linear and logistic learning, support vector machines	In Class	Linear regression Regression model, regression line, single and multiple variable, error, LMS algorithm. Logistic regression & Support vector machines Sigmoidal function used. Types of function, support vectors, functional margin, geometrical margin, optimization function	6	3	3	1

	Assignment Topics					
Module 4 Neural network and Deep learning	In Class	Analogy between biological and artificial neural network, structure, Mc culloch and pitts model, Perceptron model, Use of neural network to solve different logic gates Backpropagation algorithm, implementation, deep learning structure	5	4	3	1
	Assignment Topics	Neural network tool in MATLAB	1	5	3	1
Module 5 K nearest neighbour and Clustering technique	In Class	KNN, voronoi diagram, lazy algorithm, learning algorithm. Different Clustering techniques	6	5	3	1
	Assignment Topics					

Books:

1. Miroslav Kubat, "An Introduction to Machine Learning", ISBN 978-3-319-20009-5. DOI 10.1007/978-3-319-20010-1.

Weblink:

1. https://archive.nptel.ac.in/courses/106/105/106105152/

VI SEMESTER B.TECH. (E & E)
OPEN ELECTIVE-IV

EE307A2 **Credit: 4 (L-3, T-1, P-0)**

DIGITAL IMAGE PROCESSING

Questions to be set:05 (All Compulsory)

Course Objectives:

- To define the scope of the field that we call image processing.
- To give a historical perspective of the origins of this field.
- To give an idea of the state of the art in image processing by examining some of the principal areas in which it is applied.
- To discuss briefly the principal approaches used in digital image processing.
- To give an overview of the components contained in a typical, general-purpose image processing system.
- To provide direction to the books and other literature where image processing work normally is reported.

Pre-requisites: Knowledge of biomedical instrumentation.

Course Outcomes (CO):

CO1 The objective of this course is to introduce basic concepts and methodologies for digital image processing.

CO2 Cover the basic theory and algorithms that are widely used in digital image processing.

CO3 Expose students to current technologies and issues that are specific to image processing systems.

CO4 Develop hands-on experience using computers to process images.

CO5 Familiarize with MATLAB Image Processing Toolbox

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Introduction and Elements of digital image processing:	In class	**Subtopic 1:** DIP Fundamentals, Steps of DI Processing System. **Subtopic 2:** Image acquisition, storage, processing, communication, display. **Subtopic 3:** Convolution and correlation, sampling, FFT algorithm, the inverse FFT.	8	1		
	**Assignment Topics	Neighbors of a pixels, relations, equivalence and transitive closure.				
Module 2: Some basic mathematical concepts and image enhancement	In class	**Subtopic 1:** Neighbors of a pixels, connectivity, labeling of connected components. **Subtopic 2:** Some simple intensity transformation, histogram processing, image subtraction, image averaging. **Subtopic 3:** Background, smoothing filters, sharpening filters	8	2		

	****Assignment Topics**	Pixels distance measures, arithmetic/logic operations				
Module 3: Image compression models:	In class	**Subtopic 1:** Low pass filtering, high pass filtering, homomorphic filtering. **Subtopic 2:** The source encoder and decoder,the channel encoder and decoder	6	3		
	**Assignment Topics	Walsh transform, Hadamard transform, Discrete cosine transform,				
Module 4: Error free and Lossy compression	In class	**Subtopic 1:** Variable length coding, bit plane coding, lossless predictive coding. **Subtopic 2:** Lossy predictive coding, transform coding, image compression standards	7	4		
	****Assignment Topics**	The Haar transform, The Slant transform				
Module 5: Image segmentation:	In class	**Subtopic 1:** Edge detection, Line detection, Curve detection, Detection of discontinuities **Subtopic 2:** , edge linking and boundary detection, extraction, thresholding, region orientated segmentation, recognition and interpretation.	7	5		
	****Assignment Topics**	Wavelet transformation				

Recommended Books:

1. Rafael C. Gonzalez, Richard E. Woods “Digital Image Processing”.

VII SEMESTER B.TECH. (E&E)
OPEN ELECTIVE-V

EE402A2 **Credit:4 (L-3, T-1, P-0)**

BIO-MEDICAL INSTRUMENTATION

Questions to be : 05 (All Compulsory)

Course Objectives:

- To learn the processes of Bio-medical Instrumentation
- To learn the measure biomedical and physiological information.
- To be able differentiate and analyze the biomedical signal sources.

Pre-requisites: Knowledge of measurement, Electro-physological measurement, Medical Imaging and Telemetry

Course Outcomes (CO):

CO1 Learn the physiology of biomedical system
CO2 Learn the measure biomedical and physiological information.
CO3 Learn the differentiate and analyze the biomedical signal sources
CO4 Construct basic non-invasive diagnostic parameters.
CO5 Apply design procedures to design basic nervous and related measurements.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: ANATOMY, PHYSIOLOGY AND TRANDUCERS	In class	**Sub topic 1:** Brief review of human physiology and anatomy – cell and their structures – electrical mechanical and chemical activities. **Sub topic 2**: action and resting potential – different types of electrodes – sensors used in biomedicine **Sub topic 3:** selection criteria for transducers and electrodes – electrical safety – grounding and isolation.	8	1	1,2	1
	**Assignment Topics					
Module 2: NON-ELECTRICAL PARAMETER MEASUREMENTS	In class	**Sub topic 1:** Measurement of blood pressure – blood flow cardiac output. **Sub topic 2:** Cardiac rate – heart sound.	7	2	1,2	1
	Assignment Topics					
Module 3: MEDICAL IMAGING AND TELEMETRY	In class	**Sub topic 1:** X-RAY machine – computer tomography – magnetic resonance imaging system –. **Sub topic 2:** Ultra sonography – endoscopy – different types of telemetry system	7	3	1,2	1
	**Assignment Topics					

Module 4: ASSISTING AND THERAPETIC DEVICES:	In class	**Sub topic 1:** Cardiac pacemakers – defibrillators- ventilators – muscle stimulators – diathermy **Sub topic 2:** – introduction to artificial kidney, artificial heart – heart lung machine	7	4	1,2	1
	****Assignment Topics**					
Module 5: Sequential circuits	In class	**Sub topic 1:** ECG – EEG lead system and recording methods – typical waveforms. **Sub topic 2:** EMG – ERG –lead system and recording methods – typical waveforms.	7	5	1,2	1
	****Assignment Topics**					

TEXT BOOKS:

1. Medical Instrumentation-Application & Design, John G. Webster, Wiley.
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "*Biomedical Instrumentation and Measurements*", Prentice Hall
3. Geddes L. A. and Baker L. E., "*Principles of Applied Biomedical Instrumentation*", John Wiley.

REFERENCE BOOKS:

1. Richard Aston, "Principles of Bio-medical Instrumentation and Measurement", Merril Publishing Company.
2. Kandpur R. S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.

ELECTRICAL & ELECTRONICS ENGINEERING

(VALUE ADDED SUBJECTS)

III SEMESTER B.TECH. (E & E)

EE201A5 **Credit: 1 (L-0, T-0, P-2)**

PROJECT BASED LEARNING-I

Objective: To motivate the students in research/paper publication/practical application which will help them in understanding/analysis/formulating the problem related to the advanced and relevant areas of engineering.

Course Outcome: On successful completion of course students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.

Pre-requisite: None.

Project Based Learning projects should be done by the students starting from 1st semester for which a teacher is assigned to the student(s) under whom he/she/they will work. **Project Based Learning-I** is the part of the curriculum in Semester-III with credit 1.0. Minimum contact hour per week is 2 hrs.

IV SEMESTER B.TECH. (E&E)

GN201A1 **Credit: 3 (L-2, T-1, P-0)**

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT

Course Objectives:

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much needed orientational input in value education to the young enquiring minds.

Pre-requisites: None. However, it is desired that students may have gone through UHV-I: Universal Human Values-Introduction

Course Outcome (CO):

1. Students are expected to understand self-exploration and Basic Human Aspirations.
2. To understand harmony in themselves (Human being).
3. To become more aware of their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
4. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1) Holistic vision of life
2) Socially responsible behaviour
3) Environmentally responsible work
4) Ethical human conduct
5) Having Competence and Capabilities for Maintaining Health and Hygiene
6) Appreciation and aspiration for excellence (merit) and gratitude for all

Module 1 –Introduction to Value Education (9 Hrs)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session *PS1* *Sharing about Oneself*
Lecture 3: Self-exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice Session PS*2 Exploring Human Consciousness*
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfil the Basic Human Aspirations
Tutorial 3: Practice Session PS*3 Exploring Natural Acceptance*

Module 2 – Harmony in the Human Being (9 Hrs)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body
Lecture 8: Distinguishing between the Needs of the Self and the Body
Tutorial 4: Practice Session PS*4 Exploring the difference of Needs of Self and Body*
Lecture 9: The Body as an Instrument of the Self
Lecture 10: Understanding Harmony in the Self
Tutorial 5: Practice Session PS*5 Exploring Sources of Imagination in the Self*
Lecture 11: Harmony of the Self with the Body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS*6 Exploring Harmony of Self with the Body*

Module 3 – Harmony in the Family and Society (9 Hrs)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS*7 Exploring the Feeling of Trust*
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS*8 Exploring the Feeling of Respect*
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS*9 Exploring Systems to fulfil Human Goal*

Module 4 – Harmony in the Nature/Existence (6 Hrs)

Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation, and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS*10 Exploring the Four Orders of Nature*
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS*11 Exploring Co-existence in Existence*

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (9 Hrs)

Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS*12 Exploring Ethical Human Conduct*

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS*13 Exploring Humanistic Models in Education*

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS*14 Exploring Steps of Transition towards Universal Human Order*

Content for Practice Sessions (Tutorials)

In order to connect the content of the proposals with practice (living), 14 practice sessions have been designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

PS1Sharing about Oneself

PS2Exploring Human Consciousness

PS3Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being

PS4 Exploring the difference of Needs of Self and Body

PS5 Exploring Sources of Imagination in the Self

PS6Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust PS8 Exploring the Feeling of Respect

PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Text Book

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1

The Teacher's Manual

Teachers' Manual for *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.

6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

IV SEMESTER B.TECH. (E & E)

EE202A5 **Credit: 1 (L-0, T-0, P-2)**

Project Based Learning-II

Objective: To motivate the students in research/paper publication/practical application which will help them in understanding/analysis/formulating the problem related to the advanced and relevant areas of engineering.

Course Outcome: On successful completion of course students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.

Pre-requisite: None.

Project Based Learning projects should be done by the students starting from 1st semester for which a teacher is assigned to the student(s) under whom he/she/they will work. Project Based Learning-II is the part of the curriculum in Semester-IV with credit 1.0. This is in continuation with **Project Based Learning –I** (**Semester-III**). Minimum contact hour per week is 2 hrs.

V SEMESTER B.TECH.(E&E)

EE301A5 **Credit: 1 (L-0, T-0, P-2)**

PROJECT BASED LEARNING-III

Objective: To motivate the students in research/paper publication/practical application which will help them in understanding/analysis/formulating the problem related to the advanced and relevant areas of engineering.

Course Outcome: On successful completion of course students will:

1. Utilize the theoretical knowledge on actual application.
2. Visualize the practical application of electrical equipment.
3. Able to develop new concept for various applications.

Pre-requisite: None.

Project Based Learning projects should be done by the students starting from 1st semester for which a teacher is assigned to the student(s) under whom he/she/they will work. Project Based Learning-III is the part of the curriculum in Semester-V with credit 1.0. This is in continuation with **Project Based Learning –II** (Semester-IV). Minimum contact hour per week is 2 hrs.

V SEMESTER B.TECH. (E&E)

GN301A1 **Credit: 1 (L-1, T-0, P-0)**

QUANTITATIVE APTITUDE AND LOGICAL REASONING - I

Questions to be set: 05 (All Compulsory)

Course Objective: The main aim of introducing "Quantitative Aptitude & Logical Reasoning" to university students is to develop numerical skills among students and to prepare them for various examinations to enhance better job prospects. This initiative is being taken to include essential mathematical principles to build students' confidence. It is expected to expand students' knowledge and foster their logical reasoning and analytical thinking abilities.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO	STATEMENT
CO1	Student will be able to solve variety of simple problems in the space of quantitative domain.
CO2	Students will be able to use data to determine or to deduce other facts from a set of given data of less complexity.
CO3	Students will be able to use shortcuts, tricks and techniques to solve the problems with moderate accuracy.
CO4	Students will be able to demonstrate essential skills pertaining to public speaking, resume writing and telephone etiquette.
CO5	Students will be able to demonstrate basic skills during the placement interviews

Module	Topics to be covered	Topics	Hrs.	CO	PO	PSO
Module 1: **Quantitative Aptitude**	In class	Problems on Trains, Time and Distance, Height and Distance, Time and Work, Simple Interest, Compound Interest, Profit and Loss, Partnership, Percentage, Problems on Ages, Calendar, Clocks, Average, Area, Volume and Surface Area	6	1		
Module 2: **Puzzles, Problem Solving and Analysis**	In class	Sudoku, Number Puzzles, Missing Letter Puzzles, Playing Card Puzzles, Clock Puzzles.	3	2		
Module 3: **Logical Reasoning**	In class	Number Series, Letter and Symbol series, Verbal Classification Essential Part, odd man out and visual reasoning, Analogies, Artificial Language, Matching Definitions, Making Judgements.	5	3		
Module 4: **Professional Builder**	In class	Resume Writing, Public Speaking, Extempore, Telephone etiquette.	4	4		
Module 5: **Use Cases**	In Class	Mock Interview – Hard and Soft Skills Sector: FMCG, IT, Production, Manufacturing etc.	2	5		

Text books:

1. Aggarwal, R. S. (2008). Quantitative Aptitude. S. Chand., ISBN: 9788121924986, 8121924987
2. Devi, S. (2005). Puzzles to puzzle you. Orient Paperbacks., ISBN: 8122200141, 9788122200140

VI SEMESTER B.TECH. (E & E)

GN302A1 **Credit: 1 (L-1, T-0, P-0)**

QUANTITATIVE APTITUDE AND LOGICAL REASONING - II

Questions to be set: 05 (All Compulsory)

Course Objective:

The key objective of this course is to strengthen the numerical skills and logical abilities & skills of university students and prepare them for various competitive exams, thereby improving their employment opportunities. This initiative aims to incorporate fundamental mathematical principles to build students' confidence. Additionally, it seeks to broaden their knowledge and foster their logical reasoning and analytical thinking skills.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO	STATEMENT
CO1	Student will be able to solve variety of problems simple to complex in the space of quantitative domain.
CO2	Students will be able to use data to determine or to deduce other facts from a set of given data which are simple to complex.
CO3	Students will be able to use shortcuts, tricks and techniques to solve the problems with high accuracy.
CO4	Students will be able to demonstrate essential skills pertaining to business communications.
CO5	Students will be able to demonstrate advanced skills required at the time of placement interviews.

Module	Topics to be covered	Topics	Hrs.	CO	PO	PSO
Module 1: **Quantitative Aptitude**	In class	Problems on Permutations and Combinations, Probability, Numbers, Problems on Numbers, Problems on HCF and LCM, Decimal Fraction, Simplification, Square Root and Cube Root, Surds and Indices, Ratio and Proportion, Chain Rule, Pipes and Cistern, Boats and Streams, Allegation and Mixtures, Logarithm, Races and Games, Stocks and Shares, Probability, True Discount, Odd man out and Series.	8	1		
Module 2: **Puzzles, Problem Solving and Analysis**	In class	Logical Connectives and Syllogisms, Data Interpretation, Cases, Venn Diagrams.	3	2		
Module 3: **Logical Reasoning**	In class	Verbal Reasoning, Logical Problems, Logical Games, Data Arrangement and Blood Relations, Analyzing Arguments, Statement and Assumption, Course of action, Statement and Conclusion, Theme Detection, Cause and Effect, Statement and Argument, Logical Deduction.	4	3		
Module 4: **Professional Builder**	In class	CV Writing, Verbal & Non Verbal Communication, Group Discussion, Netiquettes,	2	4		
Module 5: **Use Cases**	In Class	Mock Interview on Hard and Soft Skills Sector - IT, FMCG, Product, Financials, Manufacturing, Production, Construction etc.	3	5		

Text books:

1. Aggarwal, R. S. (2008). *Quantitative Aptitude*. S. Chand., ISBN: 9788121924986, 8121924987
2. Devi, S. (2005). *Puzzles to puzzle you*. Orient Paperbacks., ISBN: 8122200141, 9788122200140

ELECTRICAL & ELECTRONICS ENGINEERING

(Specializations)

Specialization-I

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

SCHEME (Total Credits: 24)

Subject Code	Subject Name	L	T	P	C	Semester
EE204A8	Foundations of EV & Hybrid Vehicles	3	1	0	4	III
EE205A8	EV Battery Technology and Powertrain Development	3	1	0	4	IV
EE303A8	EV Power Electronics & Embedded Systems	3	1	0	4	V
EE304A8	EV Charging Infrastructure, Vehicle Testing & Homologation	3	1	0	4	VI
EE405A8	EV Vehicle Design & Analysis	3	1	0	4	VII
EE406A8	EV PCB Design & Data Analytics	3	1	0	4	VIII

III SEMESTER B.TECH. (E&E)

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

EE204A8 **Credit: 4 (L-4, T-0, P-0)**

FOUNDATIONS OF EV & HYBRID VEHICLES

Questions to be set: 05 (All Compulsory)

Course Objective:

1. To provide the performance characteristics of electric and hybrid vehicles.
2. To explain the environmental impact and sustainability considerations associated with electric and hybrid vehicles
3. To understand the design and operation of charging infrastructure, as well as power management systems in electric and hybrid vehicles.
4. To teach the learners on how to integrate various components at the system level to ensure efficient and reliable operation of electric vehicles

Pre-requisites: Fundamentals of Maths and Science

Course Outcomes (CO): On Successful Completion of the course students will:

CO	STATEMENT
CO1	Apply the fundamental principles of Science and Engineering, and study the performance characteristics of electric and hybrid vehicles.
CO2	Relate the environmental impact, sustainability aspects, and policy/regulatory dynamics of electric and hybrid vehicles.
CO3	Demonstrate knowledge of Electrical power, Control System and analysis.
CO4	Demonstrate knowledge of charging infrastructure, power management systems, and emerging trends in the electric and hybrid vehicle field.
CO5	Illustrate the component level integration of Electric Vehicles.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Principles for Electric Vehicles**	In class	EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology	9	1		
	Assignment topics					
Module 2: **Control system for Electric Vehicles**	In class	Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture	9	2,3		
	Assignment topics					
Module 3: **Essentials for Electric Vehicles**	In class	Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis	9	3		
	Assignment topics					

Module 4: **Types of components in Electric Vehicles**	In class	EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components	9	4		
	Assignment topics					
Module 5: **Principles for Hybrid Vehicles**	In class	Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV	9	5		
	Assignment topics					

Text Book:

1. Electric Vehicle Technology Explained" by James Larminie and John Lowry.
2. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain
3. "Electric Vehicle Systems Architecture and Standardization Needs" by Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi
4. "Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids" by Jia-Sheng Zhang and David Xu
5. "Advanced Electric Drive Vehicles" edited by Ali Emadi

Reference books:

1. "Electric Vehicle Technology" by Anant V. Kulkarni
2. "Power Electronics and Electric Drives for Traction Applications" by Gonzalo Abad and Sergio Busquets-Monge
3. "Electric Vehicle Integration into Modern Power Networks" by Yasser Abdel-Rady Ibrahim
4. "Electric Vehicles: Prospects and Challenges" edited by Majid Nayeripour, Subhas Chandra Mukhopadhyay, and Vijay Kumar Devabhaktuni
5. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives" by Christopher Mi

E Books / MOOCs/ NPTEL:

1. "Introduction to Electric Vehicles" - offered by Indian Institute of Technology Delhi on NPTEL Link: https://onlinecourses.nptel.ac.in/noc21_ee05/preview

IV SEMESTER B.TECH. (E&E)

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

EE205A8 **Credit: 4 (L-4, T-0, P-0)**

EV BATTERY TECHNOLOGY AND POWERTRAIN DEVELOPMENT

Questions to be set: 05 (All Compulsory)

Course Objective:

1. To explain about the battery basics, Lithium-Ion characteristics, and BMS functionality.
2. To explore the SOC/SOH estimation, cell balancing, protection, thermal management, and CAN communication and develop BMS functionality and expertise.
3. To provide expertise in electrical and mechanical design, heat transfer, and assembly. Perform thermal analysis and MATLAB/Simulink-based modeling for battery life cycle testing.
4. To train on EV powertrain components, architecture, thermal management, and types of chargers.
5. To explain the modeling, simulation, and analysis of EV powertrain components using MATLAB, SolidWorks, and ANSYS with practical case studies.

Pre-requisites: Basics of Chemistry, Battery, Electrical/Electronics

Course Outcomes (CO): On Successful Completion of the course students will:

CO	STATEMENT
CO1	Explain EV Battery Fundamentals
CO2	Develop a BMS for EV
CO3	Test for Battery Life-cycle
CO4	Demonstrate EV Charging System
CO5	Analyse the EV powertrain Components

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Battery Fundamentals**	In class	Basics of Batteries, Battery Parameters, Lithium-Ion Characteristics, Thermal Runaway Battery Management System (BMS), Functionality, Practical session - Battery Selection and Connection Process with Vehicle Sensors	9			
	Assignment topics					
Module 2: **Battery Management Systems**	In class	SOC/SOH Estimation, Cell Balancing, Protection, Thermal Management, CAN Communication **Practical session** - BMS development	9			
	Assignment topics					

Module 3: **Battery Pack Design & Modelling**	In class	Overview of Battery & BMS System, Electrical Design, Mechanical Design: Calculations and Mechanical Design using ANSYS, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, MATLAB/Simulink-based Battery Pack Modelling **Practical session** - Battery life cycle testing	9			
	Assignment topics					
Module 4: **Powertrain and Charging Systems of Electric Vehicles**	In class	Introduction to EV Powertrain: Overview, Architecture and Components of EV Powertrain Thermal Management of EV Powertrain EV Charging Systems and Types of Chargers	9			
	Assignment topics					
Module 5: **Modelling, Simulation, and Analysis of EV Powertrain Components**	In class	Modelling and Simulation of EV Powertrain Components in MATLAB, Modelling and Analysis of EV Powertrain Components in SolidWorks, Analysis of EV Powertrain Components in ANSYS, **Case Study** on Powertrain of Existing Models	9			
	Assignment topics					

Text Books:

1. “Electric Vehicle Technology Explained" by James Larminie and John Lowry
2. "Electric Vehicle Battery Systems" by Sandeep Dhameja
3. "Battery Systems Engineering" by Christopher D. Rahn
4. "Lithium-Ion Batteries: Advanced Materials, Technologies, and Applications" edited by Ashok Vijh
5. "Electric Vehicle Batteries: Moving from Research towards Innovation" edited by Noshin Omar.

Reference Books:

1. "Power Electronics and Electric Drives for Traction Applications" by Gonzalo Abad and Joaquim Lois
2. "Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles" by John G. Hayes and G. Abas Goodarzi
3. "Introduction to Electric Vehicle Technology" by Jonathan P. Ratner and John G. Hayes
4. "Electric Vehicle Technology and Opportunities" by Richard F. Cullingworth
5. "Power Electronics for Electric Vehicle Charging Infrastructure" by Srdjan Lukic and Christopher Townsend.

V SEMESTER B.TECH. (E&E)

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

EE303A8 **Credit: 4 (L-4, T-0, P-0)**

EV POWER ELECTRONICS & EMBEDDED SYSTEMS

Questions to be set: 05 (All Compulsory)

Course Objective:

1. To explain the power electronics principles to EV systems, covering semiconductors, circuits, converters, and charging technologies.
2. To provide power electronics needs in renewable energy, industrial, and consumer systems. Analyze with simulations and real-world examples.
3. To explain embedded Linux programming, real-time systems, and sensor-based monitoring for vehicle engine performance enhancement.
4. To explain the microcontroller programming, real-time operating systems, and CAN communication for adaptive suspension control system in vehicles.
5. To teach about sensor and actuator integration, and design motor drive system.

Pre-requisites: Basics of Electronics/Electrical

Course Outcomes (CO): On Successful Completion of the course students will:

CO	STATEMENT
CO1	Extend the principles of Power Electronics in EV
CO2	Solve the various power electronics requirements of EV
CO3	Configure Embedded Solutions for Vehicle Engine Optimization
CO4	Develop Adaptive Suspension Control for EV using Embedded C
CO5	Integrate and Test an automated Motor Derive system for EV

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Introduction to Power Electronics**	In class	Introduction to Power Electronics, Overview of Power Electronics, Power Semiconductor Devices Power Electronic Circuits, Power Electronics for EVs EV Charging and Battery Systems, Converters and Inverters systems.	9			
	Assignment topics					
Module 2: **Integration of Power Electronics**	In class	Power Electronics in Renewable Energy Systems, Power Electronics in Industrial Systems, Power Electronics in Consumer Electronics, Design Considerations for Power Electronics Systems, Simulation Tools for Power Electronics, Case Studies and Real-world Examples	9			

in Various Systems	Assignment topics					
Module 3: **Introduction to Embedded Systems with Linux and C**	In class	Introduction to Embedded Systems, Programming C, Linux Programming for Embedded Systems, Advanced Linux Programming for Embedded Systems, Real-time Programming in Linux, Embedded Linux Systems Development, Configuring and Building Embedded Linux Systems, Cross-compiling and Deploying Applications to an Embedded Device. **Practical session** - Developing a sensor-based system for monitoring and optimizing vehicle engine performance.	9			
	Assignment topics					
Module 4: **Fundamentals of Embedded System**	In class	Microcontroller Architecture and Programming, Peripherals and Interfacing, Real-time Operating Systems (RTOS), Embedded System Design and Development, Design Process and Tools, CAN Communication Protocol with Embedded Designs, Embedded System Development Platforms, Project Management and Documentation, Testing and Debugging, Testing Strategies for Embedded Systems, Advanced Topics in Embedded Systems **Practical session** - Building an actuator-based system for adaptive suspension control in vehicles.	9			
	Assignment topics					
Module 5: **Sensor and Actuator Technology for Vehicle Systems**	In class	Sensor Systems, Microcontroller: Specifications of NodeMCU, Architecture of NodeMCU, Interfacing of Sensors and Actuators System, Interfacing of Actuators Systems, Sensor Principles and Characteristics (Including Accuracy, Resolution, Sensitivity and Response Time), Sensor and Actuator Integration in Vehicle Systems, Sensor and Actuator Selection Criteria-based on Vehicle System Requirements and Specifications. Installation, Calibration and Testing of Sensors and Actuators in Vehicle Systems Sensor and Actuator Selection Criteria-based on Vehicle System Requirements and Specifications	9			

		Practical session - Design and simulate a motor drive system				
	Assignment topics					

Text Books:

1. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control, and Integration" by Sudipta Chakraborty and Abhijit Chakraborty
2. "Power Electronics: Circuits, Devices, and Applications" by Muhammad H. Rashid
3. "Power Electronics and Motor Drives: Advances and Trends" edited by Bimal K. Bose
4. "Embedded Systems: Introduction to the Msp432 Microcontroller" by Jonathan W. Valvano
5. "Embedded Systems: Real-Time Operating Systems for Arm Cortex-M Microcontrollers" by Jonathan W. Valvano

Reference Books:

1. "Embedded Systems: Architecture, Programming, and Design" by Raj Kamal
2. "Automotive Power Electronics and Electric Drives: Principles, Techniques, and Systems" by Ali Emadi
3. "Electric Motor Drives: Modelling, Analysis, and Control" by R. Krishnan
4. "Fundamentals of Power Electronics" by Robert W. Erickson and Dragan Maksimovic
5. "Embedded Systems Design with Platform FPGAs: Principles and Practices" by Ronald Sass and Andrew G. Schmidt

VI SEMESTER B.TECH. (E&E)

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

EE304A8 **Credit: 4 (L-4, T-0, P-0)**

EV CHARGING INFRASTRUCTURE, VEHICLE TESTING & HOMOLOGATION

Questions to be set: 05 (All Compulsory)

Course Objective:

1. To explain the learners about the EV regulatory processes, including homologation, certification, and compliance with FAME India guidelines.
2. To provide effective product development planning, validation, and competitor analysis, ensuring robust design feasibility and launch strategies.
3. To develop business plans based on market analysis results, focusing on POC/MVP, working prototypes, and successful product launches in EV charging.
4. To interpret various EV charging technologies, standards, charger types, infrastructure design, site selection, and successful project case studies.
5. To design and deployment of EV charging infrastructure, charging network management, payment systems, data analytics, and successful case studies for real-world implementation.

Pre-requisites: Basics of Electrical/Electronics, Manufacturing and Product Development

Course Outcomes (CO): On Successful Completion of the course students will:

CO	STATEMENT
CO1	Interpret the various steps involved in the regulations and standards of Electric Vehicle
CO2	Demonstrate the certification process of EV
CO3	Experiment with the EV Product Development cycle
CO4	Identify various EV Charging Infrastructures
CO5	Interpret the data management in charging stations

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **EV Business Management and Vehicle Testing**	In class	Introduction to EV (2W, 3W & 4W) Market & Opportunities, Electric Vehicle Design Procedure and ICE Model, Introduction to EV Management (Categories, Regulations and Standards), EV Homologation and Testing, FAME India and Manufacturing Guidelines, EV Certification Process, EV Charging, Electric Vehicle and Retrofitting, Motor Technology and EV Motor Market Analysis, EV Categories and Proposed Changes, EV Retrofitting Business, Battery Technology in EV, EV Battery Market Analysis	9			

		Practical session - Conducting a market analysis of the EV Charging				
	Assignment topics					
Module 2: **Fundamentals of Product Development Planning**	In class	Introduction to Product Development Plan, Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Specification - Competitor Analysis, Selection of Off-the-Shelf Parts	9			
	Assignment topics					
Module 3: **Effective Development Methods for Product Innovation**	In class	Development Methods, Product Development Plan, Unit Economics, Design Feasibility, Design for Manufacturing, DFMEA & PFMEA, Business Plan, Product Launch, POC / MVP / Working Prototype **Practical session** - Using the market analysis results to develop a business plan for an EV Charging	9			
	Assignment topics					
Module 4: **Understanding EV Charging Technologies and Infrastructure**	In class	Overview of EV Charging Technologies, EV Charging Standards and Protocols, Types of EV Chargers and Charging Stations, EV Charging Infrastructure Design, Site Selection and Planning **Practical session** - Case Studies of Successful EV Charging Infrastructure Projects	9			
	Assignment topics					
Module 5: **Designing and Managing EV Charging Infrastructure**	In class	Electrical and Mechanical Design Considerations, Safety and Regulatory Compliance, EV Charging Infrastructure Installation and Maintenance, Charging Network Management, EV Charging Network Design and Deployment, Payment Systems and Revenue Management, Data Management and Analytics on Charging Station	9			
	Assignment topics					

Text Books:

1. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control, and Integration" by Sudipta Chakraborty and Abhijit Chakraborty
2. "Power Electronics: Circuits, Devices, and Applications" by Muhammad H. Rashid
3. "Power Electronics and Motor Drives: Advances and Trends" edited by Bimal K. Bose
4. "Embedded Systems: Introduction to the Msp432 Microcontroller" by Jonathan W. Valvano
5. "Embedded Systems: Real-Time Operating Systems for Arm Cortex-M Microcontrollers" by Jonathan W. Valvano

Reference Books:

1. "Embedded Systems: Architecture, Programming, and Design" by Raj Kamal
2. "Automotive Power Electronics and Electric Drives: Principles, Techniques, and Systems" by Ali Emadi
3. "Electric Motor Drives: Modelling, Analysis, and Control" by R. Krishnan
4. "Fundamentals of Power Electronics" by Robert W. Erickson and Dragan Maksimovic
5. "Embedded Systems Design with Platform FPGAs: Principles and Practices" by Ronald Sass and Andrew G. Schmidt

VII SEMESTER B.TECH. (E&E)

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

EE405A8 **Credit: 4 (L-4, T-0, P-0)**

EV VEHICLE DESIGN & ANALYSIS

Questions to be set: 05 (All Compulsory)

Course Objective:

1. To provide in-depth understanding of Electronic Control Unit (ECU) components and their integration in Electric Vehicles.
2. To explain in designing and simulating controller circuits using Proteus software for effective Electric Vehicle control systems
3. To equip students with essential MATLAB skills for programming, data analysis, and simulation, applied to Electric Vehicle systems.
4. To instruct on Simulink features supporting Power Electronics modules for Electric Vehicles, facilitating modeling and simulation of crucial EV components.
5. To explain the modeling and simulation of EV architecture using MATLAB software.

Pre-requisites: Basics of Electronics/Electrical

Course Outcomes (CO): On Successful Completion of the course students will:

CO	STATEMENT
CO1	Illustrate the Electronics Components used in ECU
CO2	Model Controller circuits using Proteus
CO3	Understand the MATLAB tool principles
CO4	Infer the various features of Simulink supporting Power modules of EV
CO5	Model EV Battery

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Introduction to Analog Electronics**	In class	Introduction to Basic Electronics, Diode Fundamentals, Rectifiers and Filters, Power Electronics for EVs: Voltage Regulators, Inverters and Converters, Special Purpose Diodes, Transistors and Types of Transistors, Operational Amplifier (Op-Amp)	9			
	Assignment topics					
Module 2: **Fundamentals of Digital Electronics**	In class	Digital Electronics, EV Control Systems, EV Communication Networks, Microcontrollers and Microprocessors, Introduction to Proteus Software, Circuit Development Using Proteus	9			
	Assignment topics					
Module 3:	In class	Overview and Environment Basic Syntax, Variables and Commands Commands, M-files, and Types Operators, Decision Making and Loops	9			

Essentials for Designing and Simulation Using MATLAB		Vectors, Matrix, and Arrays Colon Notation and Numbers Strings and Functions Numbers, Plotting and Graphics Algebra, Calculus, Differential, and Integration Polynomials and Transforms Programming EV Systems in MATLAB Simulink and Fitting Developing SIMULINK Models for Vehicle Units Advisor and QSS Toolbox QSS-based Vehicle Control **Practical session** - Analyze and troubleshoot electronic circuits using simulation tools and lab equipment				
	Assignment topics					
Module 4: **EV Architecture Modelling Using MATLAB [Software-based]**	In class	Motor Development and Induction Motor Characteristics Simulink Model to Calculate Vehicle Configuration Multi-level Inverter Design and Simulation Solar PV-based Charger Development DC-DC Converter Modelling of Li-ion Battery Pack Design of EV Using QSS Toolbox Battery Thermal Modelling BMS Modelling Electric 4W Powertrain Modelling **Practical session** - Data analysis and visualization using MATLAB for vehicle system	9			
	Assignment topics					
Module 5: **Design of EV System Using MATLAB [Software-based]**	In class	Power Required to Overcome Resistance Forces Acting on the Vehicle Power Converters in Electric Vehicles Inverters in Electric Vehicles Motor and Motor Controllers Modelling of EV Battery and BMS **Practical session** - Modeling and simulation of EV powertrain components, such as motors, controllers, and inverters, using MATLAB/Simulink	9			
	Assignment topics					

Text Books:

1. “Electric Vehicle Technology Explained" by James Larminie and John Lowry
2. "Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain
3. "Advanced Electric Drive Vehicles" edited by Ali Emadi
4. "Electric Vehicle Battery Systems" by Sandeep Dhameja

Reference Books:

1. "Power Electronics and Electric Drives for Electric Vehicles" by Haitham Abu-Rub, Baoming Ge, and Miroslav Vasic
2. "Electric Vehicle Technology" by H. S. Nalwa
3. "Introduction to Electric Vehicles" by Gregory M. Plett

VIII SEMESTER B.TECH. (E&E)

Advanced Specialization on Electric Vehicles (Electrical) in collaboration with L&T Edu Tech

EE406A8 **Credit: 4 (L-4, T-0, P-0)**

EV PCB DESIGN & DATA ANALYTICS

Questions to be set: 05 (All Compulsory)

Course Objective:

1. To explain PCB design using Altium, covering schematic capture, multi-sheet designs, netlist generation, and bill of materials.
2. To provide in-depth knowledge of designing PCBs for analog, digital, power electronics, RF/microwave, and high-speed circuits.
3. To elucidate the integration of PCB design with vehicle electrical systems, considering control modules, sensors, power electronics, and EMI/EMC considerations.
4. To instruct on data collection, pre-processing, and application of analytics techniques (regression, clustering, classification) for EV electrical systems.
5. To equip students with skills in applying Machine Learning and AI techniques for predictive maintenance, energy management, and autonomous driving in Electric Vehicles.

Pre-requisites: Basics of Electronics & Electrical

Course Outcomes (CO): On Successful Completion of the course students will:

CO	STATEMENT
CO1	Infer the fundamental concepts of PCB design using Altium software
CO2	Understand various PCB circuits of EV
CO3	Apply the engineering procedures to simulate EV PCB boards
CO4	Understand the Data Analytics principles for EV data
CO5	Apply ML and estimate the predictive maintenance rules for EV

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Introduction to PCB Design with Altium**	In class	Basic Concepts of PCB Design, Overview of Altium, its Interface and Key Features, Basic PCB Design Techniques Using Altium, Understanding Schematic Capture and Design Process, Working with Components, Symbols and Nets, Creating Hierarchical Schematics and Multi-sheet Designs, Generating Netlist and Bill of Materials	9			
	Assignment topics					
Module 2: **PCB Layout Design Techniques**	In class	PCB Layout Design, Designing PCBs for Analogue and Digital Circuits, Designing PCBs for Power Electronics, Designing PCBs for RF/Microwave Circuits, Designing PCBs for High-speed Circuits	9			
	Assignment topics					
Module 3:	In class	Understanding Vehicle Electrical	9			

Vehicle Electrical Systems and PCB Design Considerations		Systems and Network Topology, Designing PCBs for Vehicle Control Modules and Sensors, Designing PCBs for Power Electronics Used in Vehicles, EMI/EMC Considerations in PCB Design for Vehicles, Simulation and Verification **Practical session** – Exposure to PCB fabrication process using basic PCB fabrication techniques, such as etching and drilling.				
	Assignment topics					
Module 4: **Data Analytics and EV Electrical Systems**	In class	Introduction to Data Analytics and EV Electrical Systems, Data Collection and Pre-processing, Data Collection Methods and Techniques in EV Electrical Systems, Data Pre-processing and Cleaning Techniques, Introduction to Data Visualization and Exploration, Data Analysis Techniques for EV Electrical Systems, Overview of Data Analysis Techniques (Regression, Analysis, Clustering and Classification), Application of Data Analysis Techniques in EV Electrical Systems, Data Analytics Platforms for EV Electrical Systems, Case Studies and Projects **Practical session** - Developing predictive maintenance models for electrical systems	9			
	Assignment topics					
Module 5: **Machine Learning and AI Techniques in EV Electrical Systems**	In class	Machine Learning and AI Techniques for EV Electrical Systems, Introduction to Machine Learning and Artificial Intelligence (AI) Techniques in EV Electrical Systems, Application of Machine Learning and AI Techniques in EV Electrical Systems (Predictive Maintenance, Energy Management and Autonomous Driving) **Practical session** - Case studies showcasing the application of data analytics in the EV industry	9			
	Assignment topics					

Text Books:

1. “Mastering Electronics Design with Altium Designer" by Simon Monk.
2. “Printed Circuit Board Basics for Dummies" by Doug Brooks and Clive Maxfield.
3. "PCB Design Using AutoCAD" by Chris Schroeder.
4. "Advanced Signal Integrity for High-Speed Digital Designs" by Stephen H. Hall and Howard L. Heck.
5. "PCB Design for Manufacturing" by Nuri Dagdeviren.
6. “Data Science for Business" by Foster Provost and Tom Fawcett.

Reference Books:

1. "Big Data Analytics: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti.
2. "Data Analytics for Intelligent Transportation Systems" edited by Mashrur Chowdhury and Hesham Rakha.
3. "Electric Vehicle Data Analytics for Smart Charging and Grid Integration" by Maximilian Irlbeck, Franziska Briese, and Julian Schindler.
4. "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel.
5. "Electric Vehicle Integration into Modern Power Networks" by Zechun Hu and Hao Ma.
6. "Data Analytics for Renewable Energy Integration: Second ECML PKDD Workshop, DARE 2014, Nancy, France, September 19, 2014" edited by Wei Lee Woon and Georgia C. K. M. Quek.

Specialization-II
(Electric-Drive Vehicle Engineering)

SCHEME (Total Credits: 24)

Sl. No.	Subject Code	Subject Name	Credit	Semester
1	EE203A2/ EE201A8	Introduction to Hybrid and Electric Vehicles	4	III
2	EE208A2 / EE203A8	Sustainable and Renewable Energy Technology	4	IV
3	EE304A2 / EE301A8	Energy Storage Technology	4	V
4	EE310A2 / EE302A8	Foundations of Optimization	4	VI
5	EE401A2 / EE401A8	Basics of Data Science with Python Programming	4	VII
6	EE404A2 / EE403A8	Advance Power Converters	4	VIII
		Total	**24**	

Specialization-III
(Power and Energy Systems)

SCHEME (Total Credits: 24)

Sl. No.	Subject Code	Subject Name	Credit	Semester
1	EE204A2 / EE202A8	Computational Intelligence for Power Applications	4	III
2	EE208A2 / EE203A8	Sustainable and Renewable Energy Technology	4	IV
3	EE304A2 / EE301A8	Energy Storage Technology	4	V
4	EE310A2 / EE302A8	Foundations of Optimization	4	VI
5	EE403A2 / EE402A8	Smart Grid	4	VII
6	EE405A2 / EE404A8	Power Electronics for Renewable Energy Technologies	4	VIII
		Total	**24**	

III SEMESTER B.TECH. (E&E)

EE203A2 / EE201A8 **Credit: 4 (L-3, T-1, P-0)**

INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES

Questions to be set: 05 (All Compulsory)

Course Objectives: This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The course goes deeper into the various aspects of hybrid and electric drive train such as their configuration, types of electric machines that can be used, energy storage devices, etc. Each topic will be developed in logical progression with up-to-date information. A number of chosen problems will be solved to illustrate the concepts clearly. There shall be a suite of exercises based on MATLAB and Simulink.

Course Outcome:

On successful completion of this course, students will be able to

CO1 Illustrate the block diagram to understand the fundamentals of electric and hybrid drive trains.

CO2 Analyze various drive-train topologies viz., hybrid and electric.

CO3 Design of various drive components/systems and methods for control the speed of electric and

CO4 Analyze the power flow control in hybrid and electric vehicles topologies.

CO5 Evaluate of electric propulsion unit performance and sizing of drive system.

Pre-requisites: Understanding of basic of various types of electric motors, drive systems, battery storage, and knowledge of electronic circuits.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: **Introduction to Hybrid Electric Vehicles**	In class	History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.	4	CO1	PO1	PSO1, PSO2
	** Assignment Topics					
Module 2: . Conventional Vehicles	In class	Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.	4	CO1	PO1	PSO1, PSO2
	** Assignment Topics					
Module 3: . **Hybrid Electric**	In class	**Sub-topic-1**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in	10	CO2	PO2	PSO1, PSO2

Drive-trains		hybrid drive-train topologies, fuel efficiency analysis. **Sub topic 2:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives. **Sub topic 2:** Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.				
	** Assignment Topics					
Module 4: **Electric Propulsion unit**	In class	**Sub-topic 1:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives. **Sub-topic 2:** Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	9	CO3, CO4	PO2	PSO1, PSO2
	** Assignment Topics					
Module 5: **Sizing the drive system**	In class	**Sub topic 1:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics. **Sub topic 2:** Selecting the energy storage technology, Communications, supporting subsystems. **Sub topic 3:** Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	9	CO5	PO2	PSO1, PSO2

	** Assignment Topics					

Text-Books:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books:

a) Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

b) James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

III SEMESTER B.TECH. (E&E)

EE204A2 / EE202A8 **Credit: 4 (L-3, T-1, P-0)**

COMPUTATIONAL INTELLIGENCE FOR POWER APPLICATIONS

Questions to be: 05 (All Compulsory)

Course Objectives:

- The course addresses about Fuzzy logic concepts. Algebraic and logic operations on fuzzy sets.
- Design of fuzzy membership functions and rule-based system. Defuzzification techniques. Comparison and evaluation of defuzzification methods. It is of interest to understand how the fuzzy sets could be used for various applications.
- Understanding of the need for study and applications based on neural network.
- An understanding of Genetic algorithms its working principle and application. Difference and similarities between GA and other traditional methods.
- Learning various application based on individual and hybrid techniques.

Pre-requisites: Knowledge of Power system, Matlab and engineering mathematics.

Course Outcomes (CO):

CO1 Fundamentals on Fuzzy Logic and set theory.
CO2 Study of techniques such as fuzzification and defuzzification with applications.
CO3 Understanding the concept and applications on Neural Network.
CO4 Understanding the concept and applications on Genetic Algorithm.
CO5 Understanding the applications in Power System.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Fuzzy sets , Fuzzy relation Membership functions, Fuzzy Logic and Fuzzy rule based system	In class	**Sub topic 1:** Introduction to Computational Intelligence, Intelligence machines, Computational intelligence paradigms, Rule-Based Expert Systems and Fuzzy Expert Systems, Rule-based expert systems, **Sub topic 2:** Uncertainty management, Fuzzy sets and operations of fuzzy sets, Fuzzy rules and fuzzy inference, Fuzzy expert systems, Case study: fuzzy logic controller for washing machines	2	1	1,2	1
	**Assignment Topics	Programming				
Module 2: Neural Network, Supervised and Un-supervised learning	In class	**Sub topic 1**: Artificial Neural Networks, Fundamental neuro computing concepts: artificial neurons, activation functions, neural network architectures, learning rules. Supervised learning neural networks: multi-layer feed forward neural networks, simple recurrent neural networks, time-delay neural networks, **Sub topic 2**: Supervised learning algorithms, Unsupervised learning neural networks: self-organizing feature maps, Radial basis function networks, Deep neural networks and learning algorithms. Case study: anomaly detection	9	2	1,2	1

	****Assignment Topics**	Programing				
Module 3: Fundamentals of Genetic algorithm and Genetic modeling	In class	**Sub topic 1**: Evolutionary computation, Chromosomes, fitness functions, and selection mechanisms. crossover and mutation, Genetic programming, Evolution strategies, probabilistic reasoning	9	3	1,2	1
	**Assignment Topics	Programming				
Module 4: Hybrid Network	In class	**Sub topic 1:** Hybrid Intelligent Systems, Neural expert systems, Neuro-fuzzy systems, Evolutionary neural networks,	8	4	1,2	1
	****Assignment Topics**	Programming				
Module 5: Applications	In class	**Sub topic 1:** Case study and Simulation of artificial intelligence, fuzzy evolutionary algorithms in power system applications	8	5	1,2	1
	****Assignment Topics**	Programming				

TEXT BOOKS/ REFERENCES:

1. Timothy J Ross, "Fuzzy Logic with Engineering Applications", Wiley India Private Limited, 2010.
2. Laurene Fausett, "Fundamentals of neural Network, Architecture, Algorithms, and Applications", Pearson Education, 2002.
3. John Yen and Reza Langari, "Fuzzy logic, Intelligence control and Information", Pearson Education, 2003.

IV SEMESTER B.TECH. (E&E)

EE208A2 / EE203A8 **Credit: 4 (L-3, T-1, P-0)**

SUSTAINABLE AND RENEWABLE ENERGY TECHNOLOGY

Questions to be set: 05 (All Compulsory)

Course Objectives:

To impart the basic knowledge about the renewable energy sources. To inculcate the understanding about the fundamentals of solar energy. To understand the working of wind energy.

Course Outcomes(CO):

After successful completion of this course, students will be able to:

CO1 To Understand the Need, importance and scope of sustainable and renewable energy resources.
CO2 Estimate the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
CO3 Explore the concepts involved in wind energy conversion system by studying its components, types and performance.
CO4 To understand the role of ocean energy in the Energy Generation.
CO5 To get the utilization of Biogas plants, geothermal energy and fuel cell.

** not more than 20% of total topics to be allotted for assignment

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1: Challenges of Energy Sustainability. Future Energy Systems and International agreements/conventions on Energy and Sustainability	in class	Clean/Green Energy Technologies. Classification, comparison of conventional fossil fuel and non-conventional energy sources. Problems with fossil fuels, possible solution, United Nations Framework Convention on Climate Change (UNFCC) sustainable development.	2	1		
	****Assignment Topics**	Renewable energy utilization in ancient times		1		
Module 2: **Solar Energy**	in class	Solar radiation measurements, Effects of changes in tilt angle, Sun Tracking, PV cell : Principle, types , PV Module and Array , Modelling of PV cell, Effects of shaded and faulty cell, Maximum power tracking, Charge Controllers, MPPT Algorithms, Stand Alone PV System, Grid Connected PV System, Hybrid Systems.	14	2		

	****Assignment Topics**	Practice problem based on solar energy.		2		
Module 3: **Wind Energy**	in class	Atmospheric circulations, Wind monitoring and resource assessment, modelling, Types and characteristics of wind turbines, thrust and torque, power coefficient, thrust coefficient, axial interference factor, Pitch and stall regulation, power curve, energy calculation, Principle of operation, types, configurations: WT-IG, WT-DWIG, WTDOIG, WT-PMG and WTVSIG. Small WEGs - standalone/grid connected applications.	10	3		
	****Assignment Topics**	Practice problem based on wind energy.		3		
Module 4: **Other Renewable Energy Technologies**	in class	Biomass-Gasifiers, Small hydro, wave, tidal, ocean thermal, geothermal.	7	4		
	****Assignment Topics**	Problems related to ocean energy.		4		
Module 5: **Energy Storage and State of the Art in Power& Energy industry and R&D**	in class	Principles of Battery, Super capacitor, Fuel cells, its operation, types, applications, Various Hardware and software experiments on solar PV cell and Module, standalone system design and development, MPPT tracking and control algorithm, Wind energy systems.	4	5		
	****Assignment Topics**	Concept of hybrid energy systems.		5		

1. **Text Books:** G D Rai, "Non- Conventional Energy Sources", Khanna Publishers

2. **Reference Books:**
   Non-conventional energy resources by "Dr. B. H. Khan".

V SEMESTER B.TECH. (E&E)

EE304A2 / EE301A8 **Credit: 3 (L-3, T-0, P-0)**

ENERGY STORAGE TECHNOLOGY

Questions to be set: 05 (All Compulsory)

Course Objectives: This course introduces the fundamental concepts, principles, analysis and design of energy storage devices storage and management with modeling and analysis of distribution system.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of this course, students will be able to

CO1 Analyze fundamental aspects of different energy storage strategies used in electric vehicles

CO2 Design battery based, fuel cell based, super capacitor based flywheel based energy storage technologies.

CO3 Design different hybrid energy storage technologies

CO4 Design different energy management strategies used in electric vehicle.

CO5 Analyze different implementation issues in energy management strategies.

Module	Topics to be covered	Topics	Hrs	CO	PO	PSO
Module 1 (Fundamental aspects of energy storage technologies)	In Class	Requirements of energy storage in Hybrid and Electric Vehicles, Classification of different energy storage techniques.	7	1		
	Assignment Topics					
Module 2 (Design of different energy management system)	In Class	Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis	8	2		
	Assignment Topics					
Module 3 (Hybrid energy storage technology)	In Class	Battery capacitor hybrid, battery fuel cell hybrid, battery flywheel hybrid, capacitor flywheel hybrid	7	3		
	Assignment Topics					
Module 4 (Energy management system design)	In Class	Analysis of different energy management system for hybrid and electric vehicles, Classification of different energy management strategies	7	4		
	Assignment Topics					
Module5 (Implementation issues of energy management)	In Class	Comparison of different energy management strategies, Implementation issues of energy management strategies.	7	5		
	Assignment Topics					

REFERENCES

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

VI SEMESTER B.TECH. (E&E)

EE310A2 / EE302A8 **Credit: 4 (L-3, T-1, P-0)**

FOUNDATIONS OF OPTIMIZATION

Questions to be: 05 (All Compulsory)

Course Objectives:

- The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too.
- After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

Pre-requisites: Knowledge of matlab, numerical analysis techniques.

Course Outcomes (CO):

CO1 Knowledge of basic optimization problem.
CO2 Ability to formulate decision problems as optimization problems.
CO3 Ability to solve simple single and multivariable optimization problems.
CO4 Ability to apply nontraditional optimization algorithms to solve problems.
CO5 Capable to use different tools to solve optimization problem.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Introduction	In class	**Sub topic 1:** Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.	2	1	1,2	1
	**Assignment Topics	Programming				
Module 2: Single Variable Optimization	In class	**Sub topic 1:** Optimality Criteria, Bracketing methods: Exhaustive search methods, **Sub topic 2:** Region - Elimination methods; Interval halving method, Fibonacci search method, **Sub topic 3:** Point-estimation method; Successive quadratic estimation method. **Sub topic 4:** Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Computer programs.	9	2	1,2	1
	****Assignment Topics**	Numerical				
Module 3: Multivariable optimization algorithm	In class	**Sub topic 1:** Optimality criteria, Unidirectional search, Direct search methods. **Sub topic 2:** Evolutionary optimization method, Simplex search method, Hooke-Jeeves pattern search method. **Sub topic 3:** Gradient based methods: Cauchy's (Steepest descent) method, Newton's method.	9	3	1,2	1

	**Assignment Topics	Programming				
Module 4: Constrained optimization algorithm	In class	**Sub topic 1:** Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, **Sub topic 2:** Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, Convex method.	8	4	1,2	1
	****Assignment Topics**	Programming				
Module 5: Nontraditional optimization algorithm	In class	**Sub topic 1:** Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, Advanced GAs, Differences between GAs and traditional methods, Computer programs. **Sub topic 2:** Simulated annealing method, working principles, Computer programs.	8	5	1,2	1
	****Assignment Topics**	Programming				

REFERENCES

1. Kalyanmoy Deb, Optimization for Engineering Design - Algorithms and Examples, 2nd Edition.

VII SEMESTER B.TECH. (E&E)

EE401A2 / EE401A8 **Credit:4 (L-3, T10, P-0)**

BASICS OF DATA SCIENCE IN PYTHON PROGRAMMING

Questions to be set: 05(All compulsory)

Course objectives:

1. To Teach the basic requirement and process of data science.
2. To introduce Basic statistical analysis and machine learning methods.
3. To demonstrate the use of Python and Jupyter notebooks.

Pre Requisites: Basics of computers and basic programming skills in Java/C/C++.

Course outcomes:

1. Usage basic python syntax.
2. Understand the concept of advanced dynamic data types.
3. Understand the concept data science libraries and functions.
4. Understand advanced data processing with file handling.
5. Be capable of undertaking a small scale project on data science.

Module	Topics to be covered in class	Topics	Hrs	CO	PO	PSO
Module 1	In class	Introduction: Welcome and overview of the course. Introduction to the data science process, statistics and the value of learning data science. Provide a brief background in python or unix to get you up and running	6	1	1,5	1,2
	Assignment topics					
Module 2	In class	Basics of python language, functions and datatypes, lists and dictionaries. Basic operations and syntax, data handling and plotting operations	6	2	1,5	1,2
	Assignment topics					
Module 3	In class	Jupyter and Numpy: Jupyter notebooks code are used for the analysis. Numpy functions and processes for data structures for time and space efficiency. Pandas: Pandas, Data frames functionality and features.	6	3	1,5	1,2
	Assignment topics					
Module 4	In class	Data extraction and processing from files and network sources, process the data using panda, numpy, dataframe and perform the required analysis.	6	4	1,5	1,2
	Assignment topics					
Module 5	In class	Learn variety of statistical techniques such a distributions, sampling and t-tests. Project undertaking for a given problem. Discussions on output of project. Discussions on the fourth paradigm -- data driven discovery of the future.	6	5	1,5	1,2

	Assignment topics					

Text books:

1. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media Publication
2. Bernd Jahne and Horst HauBecker, Computer vision and Applications, Academic Press, 2000
3. David A. Forsyth & Jean Ponce, Computer vision-A modern Approach, Prentice Hall, 2002

Reference Books:

1. Andries P. Engelbrecht , "Computational Intelligence: An Introduction", Wiley 2nd Edition, 2007
2. Robin R. Murphy, "Introduction to AI Robotics", MIT Press, 2000
3. Leandro N. de Castro and Jonathan Timmis, "Artificial Immune system: A new Comp utational Intelligence Approach", Springer-Verlag, Germany 2002.

VII SEMESTER B.TECH. (E&E)

EE403A2 / EE402A8 **Credit: 4 (L-3, T-1, P-0)**

SMART GRID

Questions to be : 05 (All Compulsory)

Course Objectives:

- To introduce the fundamental concepts of modern day power grid (smart Grid).
- To understand various technologies involved in smart gird.
- To understand micro grid and its operation and control.
- Identify different tools and approaches to modelling a Smart Grid.

Pre-requisites: Basic knowledge of power systems, computer and communications networks and renewable energy systems.

Course Outcomes (CO):

CO1 Develop a basic understanding of the elements and structure of smart grid.
CO2 Learn different communication, measurement and control technologies used in smart grid.
CO3 Learn the power electronics and energy storage technologies used in smart grid.
CO4 Develop basic understanding of microgrid, its operation and control.
CO5 Conduct performance and stability analysis of smart grid and case studies on smart grid.

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Introduction to Smart Grid	In class	**Sub topic 1:** Smart Grid: Need and attributes, comparison with conventional power grid, Smart grid scenario in Indian power sector, standards for smart grid system. **Sub topic 2:** Smart grid architecture.	7	1	1,2	1
	**Assignment Topics					
Module 2: Communication, Measurement and control Technologies in Smart Grid	In class	**Sub Topic 1:** Communication channels, communication Network Structures and communication technologies. **Sub topic 2:** Sensing, measurement, control and automation technologies: Smart Meters, Advanced Metering Infrastructure (AMI) and Automated Meter Reading (AMR), Phasor Measurement Unit (PMU), SCADA and WAMS system, Demand side integration. Geographical Information System, Multi-agent technology, artificial intelligence and machine learning for Smart grid applications.	7	2	1,2	1
	****Assignment Topics**					
Module 3: Power Electronics and Energy storage	In class	**Sub Topic 1:** Role of power electronics in smart grid and its applications. **Sub topic 2:** Energy storage systems, applications in smart grid.	7	3	1,2	1

technologies in Smart Grid.						
	**Assignment Topics	Advantages and challenges of different energy storage systems.				
Module 4: Micro Grid	In class	**Sub topic 1:** Micro grid: Benefits, distributed generation, control, islanded and non-islanded operation, synchronous and asynchronous operation.	7	4	1,2	1
	****Assignment Topics**					
Module 5: Operation & Control concepts in Smart grid and case studies of smart grid.	In class	**Sub topic 1:** State estimation, load flow, optimal load flow, security constrained load flow **Sub topic 2:** stability analysis, economic dispatch, self healing, resilience and reliability. **Sub topic 3:** Case study and simulations: Design of smart grid and practical smart grid case study.	8	5	1,2	1
	****Assignment Topics**					

TEXT BOOKS / REFERENCES:

1. Ali Keyhani, “Design of Smart Power Grid Renewable Energy Systems”, John Wiley & Sons, IEEE Press 2011.
2. James Momoh, “Smart Grid - Fundamentals of Design and Analysis”, John Wiley & Sons, IEEE Press 2012.
3. JanakaEkanayake, N. Jenkins, K. Liyanage, J. Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley

VIII SEMESTER B.TECH. (E&E)

EE404A2 / EE403A8 **Credit: 4 (L-3, T-1, P-0)**

ADVANCE POWER CONVERTERS

Questions to be set: 05 (All Compulsory)

Course Objectives:

- To introduce various power conversion processes or techniques.
- To provide an understanding of various power converters and power semiconductor devices, their control, protection aspects and application.
- To expose students to various topologies of the power converters.

Pre-requisites: Understanding of basic electrical and electronic devices such as diodes, transistors, MOSFETs, thyristor, IGBT, inductors, capacitors, resistors etc. Knowledge of power electronics.

Course Outcomes (CO):

CO1 Identify and choose the appropriate semiconductor switch for a given power converter application.

CO2 Design and analysis of non-isolated DC-DC converter in continuous and discontinuous conduction mode.

CO3 Design and analysis of isolated DC-DC converter.

CO4 Design and analysis of resonant converters and analysis of pulse width modulation (PWM) technique.

CO5 Design and analysis of multilevel inverters and universal power supplies (UPS).

**not more than 20% of total topics to be allotted for assignment

Module	Topics To be Covered	Topics	Hrs	CO	PO	PSO
Module 1: Advanced solid state devices	In class	MOSFETs, IGBT, SiC and GaN based devices. etc, their power modules, intelligent power modules, thermal design, protection, gating circuits, digital signal processors used in their control.	6	1		
	**Assignment Topics					
Module 2: Non-isolated DC-DC converter	In class	Generalized comparison between switched mode and linear DC regulator; Operation and steady state performance of Buck, Boost, Buck-Boost and Cuk Converters in continuous-conduction mode, discontinuous-mode and boundary between continuous and discontinuous mode of operation.	6	2		
	****Assignment Topics**					
Module 3: Isolated DC-DC converter	In class	Fly back converters and its topologies; Forward converters – Switching transition; Push-pull converter- Switching transition, limitation of the push-pull circuit; Half-bridge and Full bridge DC-DC converters – their switching transitions.	6	3		

	**Assignment Topics					
Module 4: Resonant converters and PWM	In class	Introduction and classification; zero current switch (ZCS); zero voltage switch (ZVS); ZCS- clamped voltage converters(ZCS-CV). PWM converter – Single pulse modulation, multiple pulse modulation, sinusoidal pulse width modulation.	6	4		
	****Assignment Topics**					
Module 5: Compensator Design	In class	Advantages, configurations: Diode clamped, flying capacitor and cascade multi-level inverters, applications. Redundant and Non-Redundant UPS.	6	5		
	****Assignment Topics**					

Recommended Books:

1. Mohan, Undeland, Robbins_Power Electronics: Converters, Application and Design, John Wiley & sons, 1989
2. A.I. pressman- Switching mode power supply design-MGH, 1992
3. M.H. Rashid- Power Electronics, PHI, 2004

VIII SEMESTER B.TECH. (E&E)

EE405A2 / EE404A8 **Credit: 4 (L-3, T-1, P-0)**

POWER ELECTRONICS FOR RENEWABLE ENERGY TECHNOLOGIES

Questions to be : 05 (All Compulsory)

Course Objectives: After the completion of this course the students will be able to design DC-DC converter for controlling the renewable energy. They will be able to design AC-DC-AC or AC-AC converter for controlling of wind energy. They will also learn to model the converters using MATLAB.
Pre-requisites: Basic knowledge of power systems, computer and communications networks and renewable energy systems.

Course Outcomes (CO):

CO1	Illustrate the working of dc-dc converter for renewable energy systems.
CO2	Design the closed loop control system which mainly focuses on converter control.
CO3	Conduct performance and stability analysis with simulation of dc-dc conventional converter with open and closed loop control.
CO4	Develop basic understanding of inverter with different modulation strategies and Converters in standalone power systems and grid connected.
CO5	Explore the dynamic characteristics of power semiconductor switches with experimental validations.

**not more than 20% of total topics to be allotted for assignment

Module	**Topics To be Covered**	**Topics**	**Hrs**	**CO**	**PO**	**PSO**
Module 1: Introduction to converters for renewable energy systems	In class	DC-DC converters: Buck, boost, buck-boost, Ćuk converters: operation and waveforms in CCM and DCM. Forward, fly-back and push-pull converter circuits, half bridge, full bridge converters. Resonant DC-DC converters: operating principle, waveforms	8	1	1,2	1
	**Assignment Topics					
Module 2: Converter control	In class	PWM, closed loop control, feed forward and current mode control. Driver circuits: unipolar, bipolar and isolated drives.	5	2	1,2	1
	**Assignment Topics					
Module 3: Simulation of DC-DC converters with close loop control	In class	Simulation of DC-DC converters with close loop control. Inverters: Overview, three phase converters, rectifier and inverter modes of operation for RL load. Inverter Control: PWM inverter modulation strategies, unipolar and bipolar switching scheme, sine wave PWM, space vector modulation, multi-level inverter - basic topology and waveform, improvement in harmonics.	10	3	1,2	1
	**Assignment Topics					
Module 4: Inverter with different	In class	Converters in standalone power systems, Grid connected inverters. Simulation of inverter with different modulation strategies.	4	4	1,2	1

modulation strategies	****Assignment Topics**					
Module 5: Dynamic characteristics of power semiconductor switches	In class	Dynamic characteristics of power semiconductor switches: MOSFET, IGBT – switching trajectory and losses. Snubbers: turn-off and turn-on snubbers. Magnetic design: inductor and transformer design. Simulation: Snubber implementation in converter circuits. Laboratory Experiments in above modules.	9	5	1,2	1
	****Assignment Topics**					

TEXT BOOKS/ REFERENCES:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics: Converters, Applications and Design", Third Edition, John Wiley & Sons, 2007
2. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
3. Erickson, Maksimovic, and Dragan "Fundamentals of Power Electronics", Kluwer academic publishers, 2001.