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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

III/IV B.TECH-EEE SYLLABUS

REGULATION-R19

2021-22

Third Year Semester-1

Code	Subject	Category R20	Periods						Sessional Marks	Semester End Examination Marks	Total Marks	Credits
			L	T	P	E	O	Total				
EEE 311	Open Elective-1	OE	3	0	0	1	3	7	40	60	100	3
EEE 312	Professional Elective-1	PE	3	0	0	1	3	7	40	60	100	3
EEE 313	Pulse, Digital & Integrated Circuits	PC	3	0	0	1	3	7	40	60	100	3
EEE 314	Linear Control Systems	PC	2	1	0	1	3	7	40	60	100	3
EEE 315	Performance of Induction & synchronous Machines	PC	2	1	0	1	3	7	40	60	100	3
EEE 316	Power Transmission & Distribution	PC	2	1	0	1	3	7	40	60	100	3
EEE 317	Quantitative Aptitude-1/Verbal Aptitude-1	HS	0	0	3	0	3	6	100	0	100	1.5
EEE 318	Electrical Machines Laboratory-I	PC	0	0	3	0	2	5	50	50	100	1.5
EEE 319	Electronics Laboratory-II	PC	0	0	3	0	2	5	50	50	100	1.5
	Total		**15**	**3**	**9**	**6**	**25**	**58**	**440**	**460**	**900**	**22.5**

Open Elective-1
1. Python
2. Computer Architecture and Organization
3. Java

Professional Elective-1
1. Renewable Energy Technologies
2. VLSI
3. Embedded Systems

Third Year Semester-2

Code	Subject	Category R20	Periods						Sessional Marks	Semester End Examination Marks	Total Marks	Credits
			L	**T**	**P**	**E**	**O**	**Total**				
EEE 321	Open Elective-II	OE	3	0	0	1	2	6	40	60	100	3
EEE 322	Professional Elective-II	PE	3	0	0	1	3	7	40	60	100	3
EEE 323	Professional Elective-III	PC	3	0	0	1	3	7	40	60	100	3
EEE 324	Power Electronics	PC	2	1	0	1	5	9	40	60	100	3
EEE 325	Power System Analysis	PC	2	1	0	1	6	10	40	60	100	3
EEE 326	Advanced Control Systems	PC	2	1	0	1	6	10	40	60	100	3
EEE 327	Quantitative Aptitude-2/Soft Skills	HS	0	0	3	0	2	5	100	0	100	1.5
EEE 328	Control System Laboratory	PC	0	0	3	0	1	4	50	50	100	1.5
EEE 329	Electrical Machines Laboratory-II	PC	0	0	3	0	1	4	50	50	100	1.5
	Total		**16**	**2**	**9**	**6**	**29**	**62**	**440**	**460**	**900**	**22.5**

Open Elective-2
1. Competitive Programming
2. Iot
3. Robotics

Professional Elective-2
1. Electrical Drives & Traction
2. Digital Control Systems
3. Digital Signal Processing

Professional Elective-3
1. Optimization Techniques
2. Electrical Machine Design
3. ANN & Fuzzy

Professional Elective-1 **RENEWABLE ENERGY TECHNOLOGIES**	
EEE 312	**Credits : 3**
Instruction : 3 Periods /Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO1	BL-2	**Describe** the generation of electricity from various renewable energy technologies, **calculate** the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
CO2	BL-2	**Explain** the concepts involved in wind energy conversion system by studying its components, types and performance to **calculate** wind power extracted.
CO3	BL-4	**Illustrate** ocean and geothermal energy systems to **Analyze** the operational methods of their utilization.
CO4	BL-2	**Explain** the concepts involved in biomass energy conversion system and **discuss** the merits and demerits of it.
CO5	BL-2	**Describe** Magneto hydrodynamics and Fuel cell technology and **explain** the operation of hybrid energy systems.

Program Matrix

	Program Outcomes (POs)												**PSOs**	
COs	**Domain Specific POs**					**Domain Independent Pos**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2					2					1		
CO2	2	2					2					1		
CO3	2						2					1		
CO4	2						2					1		
CO5	2						2					1		

<u>CO’S and PO’S, PSO’S Justification</u>

COs	Pos	Level	Description
CO1	PO1	2	Apply principles of basic sciences to explain different sources of electrical energy and operation of solar energy system.
CO1	PO2	2	Using the fundamentals of basic electrical engineering and mathematics to calculate the irradiation of solar energy and different angles related to solar irradiation.
CO1	PO7	2	To identify the environmental risks/ impacts on the site selection of solar power plant.
CO1	PO12	1	Recognize the need of solar energy system to meet the future demands within the environmental constraints.
CO2	PO1	2	Apply principles of basic sciences to explain the operation of wind energy system.
CO1	PO2	2	Using the fundamentals of basic electrical engineering and mathematics to calculate the wind power extracted.
CO2	PO7	2	To identify the environmental risks/ impacts on the site selection of wind power plant.
CO2	PO12	1	Recognize the need of wind power plant to meet the future demands within the environmental constraints.

CO3	PO1	2	Apply principles of basic sciences and electrical engineering to explain of operation of ocean and geothermal energy system.
CO3	PO7	2	To identify the environmental risks/ impacts on the site selection of ocean and geothermal power plant.
CO3	PO12	1	Recognize the need of ocean and geothermal power plant to meet the future demands within the environmental constraints.
CO4	PO1	2	Applying the basic principle of mathematics and electrical engineering to explain the operation of biomass energy conversion system.
CO4	PO7	2	To identify the environmental risks/ impacts on the site selection of biomass power plant.
CO4	PO12	1	Recognize the need of biomass energy conversion system to meet the future demands within the environmental constraints.
CO5	PO1	2	Apply principle of basic sciences and electrical engineering to explain the operation of MHD, fuel cells and hybrid energy system.
CO5	PO7	2	To identify the environmental risks/ impacts on the site selection of MHD, fuel cell and hybrid energy systems.
CO5	PO12	1	Recognize the need of MHD, fuel cell and hybrid energy systems to meet the future demands within the environmental constraints.

SYLLABUS

UNIT I: **[10 Periods]**

Introduction: Introduction to Energy Conversion, Principle of Renewable Energy Systems.

Solar Energy: Solar Radiation, Thermoelectric Conversion, Principles of Solar Energy collection, Characteristics and principles of different types of collectors and their efficiencies. Solar energy applications, water heaters, air heaters, solar cooling, solar cooking, solar drying and power generation, solar tower concept, solar pump, Introduction to Photovoltaic cells, PV array and PV module, Maximum power point tracking system.

UNIT II: **[10 Periods]**

Wind Energy: Wind energy, Characteristics, Aerodynamics, Power extraction, Types of wind machines, Performance of Wind Machines, Wind Mills, Applications, Economics of wind power.

UNIT III: **[10 Periods]**

Ocean & Geothermal Energy: Ocean Thermal Energy Conversion Systems, Tidal and Wave power applications. Principle of working of Geothermal Power Plants, Advantages and Disadvantages over other energy forms, Applications of Geothermal Energy.

UNIT IV: **[10 Periods]**

Bio-Energy: Energy from Bio-mass, Bio conversion processes. Bio-gas generation and utilization, Bio-gas plants various types, Industrial Wastes, Municipal waste, Burning, Plants, Energy from the Agricultural wastes.

UNIT V: **[10 Periods]**

Other Energy Sources: MHD Generators, Application of MHD generation, Fuel cells types, applications. Diesel Generator and Photo-Voltaic System, Wind-Diesel Hybrid System, Wind-Photovoltaic Systems.

Textbooks:

1. Non-Conventional Energy Sources by G.D.Rai, Khanna publishers, Fourth Edition, 2009.
2. Wind electrical systems by S.N.Bhadra, D. Kastha, S. Banerjee Oxford University press.

References:

1. Solar Energy: Principles of Thermal Collection and Storage by Sukhatme, S.P., Tata McGraw-Hill, New Delhi.
2. Fuel Cell Systems by James Larminie, Andrew Dicks, John Weily& Sons Ltd.
3. Wind Energy Explained by J.F.Manwell, J.G.McGowan, A.L.Rogers, John Weily& Sons
4. MHD Power Generation Engineering Aspects by E.J. Womack, Chapman and Hall Publication.
5. Wind Electrical Systems by S.N.Bhadra, D. Kastha, S. Banerjee Oxford University press.

Professional Elective-1 **VLSI**	
ECE 312	**Credits:3**
Instruction: 3 Periods /week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Prerequisites: Digital Electronics, ECA-I, ECA-II, IC analysis

Course Outcomes: At the end of the course, students will be able to

CO1	Delineate IC Production process, fabrication processes for NMOS, PMOS, BiCMOS Technologies.
CO2	Analyze CMOS electrical properties with circuit concepts.
CO3	Draw stick diagrams, layouts for CMOS circuits and compute delays of CMOS circuits using modern tools.
CO4	Design and test the CMOS digital Circuits at different levels of abstraction using modern tools.
CO5	Apply testing methods on the digital designs for DFT.

SYLLABUS

UNIT I **[10 Periods]**

IC Technology: MOS, PMOS, NMOS, CMOS &BiCMOS technologies- Oxidation, Lithography, Diffusion, Ion implantation, Metallization, Encapsulation, Integrated Resistors and Capacitors.

UNIT II **[10 Periods]**

CMOS Electrical Properties: Basic Electrical Properties of MOS and BiCMOS Circuits: Ids-Vds relationships, MOS transistor threshold Voltage, gm, gds, figure of merit, Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

Basic circuit concepts:

Sheet Resistance R_S and its concept to MOS, Area Capacitance Units, Calculations-Delays, driving large Capacitive Loads, Wiring Capacitances, Fan-in and fan-out, Choice of layers

UNIT III **[10 Periods]**

VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, 2 micron CMOS Design rules, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling

UNIT IV **[10 Periods]**

Gate Level Design: Logic Gates and Other complex gates, Switch logic, Alternate gate circuits. Different CMOS logic Circuits-Pseudo, Dynamic, Domino, C^2MOS.

Subsystem Design: Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators.

UNIT V **[10 Periods]**

VLSI Testing: CMOS Testing, Need for testing, Test Principles, Design Strategies for test, Chip level Test Techniques, System-level Test Techniques, Design for testability, Practical design for test guidelines, Buil-In-Self-Test

TEXT BOOKS:

Douglas A, Pucknell, Kamran Eshraghian,“Basic VLSI Design”,3rd Edition,Prentice Hall, l996.**(UNITS I, II, III, IV & V)**

1. Weste and Eshraghian, “Principles of CMOS VLSI Design”, Pearson Education, 1999

REFERENCE BOOKS:

1. John .P. Uyemura,“Introduction to VLSI Circuits and Systems”,JohnWiley, 2003.Wayne Wolf, “Modern VLSI Design”, 3rd Edition, Pearson Education, 1997

Professional Elective-1 **EMBEDDED SYSTEMS**	
ECE 312	**Credits:3**
Instruction: 3 Periods /week	Sessional Marks:40
End Exam: 3 Hours	End Exam Marks:60

Course Outcomes:

At the end of the course, students will be able to

CO1	Explore Basics of computer architecture and the binary number system
CO2	Explain the embedded systems
CO3	Identify the hardware aspects of embedded systems
CO4	Analyze the sensors, ADCs and actuators used in embedded systems
CO5	Apply the embedded systems for different real world applications

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UNIT I **[10 Periods]**

Basics of computer architecture and the binary number system

Basics of computer architecture, computer languages, RISC and CISC architectures, number systems, number format conversions, computer arithmetic, units of memory capacity

UNIT II **[10 Periods]**

Introduction to embedded systems

Application domain of embedded systems, desirable features and general characteristics of embedded systems, model of an embedded system, microprocessor Vs microcontroller, example of a simple embedded system, figure of merit for an embedded system, classification of MCUs: 4/8/16/32 bits, history of embedded systems, current trends.

UNIT III **[10 Periods]**

Embedded systems-The hardware point of view

Microcontroller unit(MCU), a popular 8-bit MCU, memory for embedded systems, low power design, pull up and pull down resistors

UNIT IV **[10 Periods]**

Sensors, ADCs and Actuators

Sensors: Temperature Sensor, Light Sensor, Proximity/range Sensor; Analog to digital converters: ADC Interfacing; Actuators Displays, Motors, Opto couplers/Opto isolators, relays

UNIT V **[10 Periods]**

Examples of embedded systems

Mobile phone, automotive electronics, radio frequency identification (RFID), wireless sensor networks(WISENET), robotics, biomedical applications, brain machine interface

TEXT BOOKS:

1. Lyla B Das, *Embedded systems: An Integrated Approach*, 1st Ed., Pearson, 2013
2. Rajkamal, Embedded Systems

REFERENCE BOOKS:

1. Shibu, K.V., *Introduction to Embedded Systems*, 1st Ed., TMH, 2009

PULSE DIGITAL AND INTEGRATED CIRCUITS

EEE 313	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

COURSE OUTCOMES:

CO1: Analyze the response of linear wave shaping circuits for different types of inputs such as step input, pulse input, square input, ramp input and Non-linear wave shaping circuits when the sinusoidal input is applied.
CO2: Infer the characteristics and analyze linear and non-linear applications of an Op-Amp.
CO3: Design and analyze active filters, oscillators for given specifications using Op-Amp.
CO4: Familiarize the conversion of data from Analog to Digital and Digital to Analog.
CO5: Design circuits for several applications using IC 555 Timer and different waveform generation.

Program Matrix

	Program Outcomes (POs)												**PSOs**	
COs	**Domain Specific Pos**					**Domain Independent Pos**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1	1	3	2	1	1	0	0	2	1	0	0	2	0
CO 2	1	1	3	2	1	1	0	0	2	1	0	0	2	0
CO 3	1	1	3	2	1	1	0	0	2	1	0	0	2	0
CO 4	1	1	3	2	1	1	0	0	2	1	0	0	2	0
CO 5	1	1	3	2	1	1	0	0	2	1	0	0	2	0

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UNIT-I **[10 Periods]**

Linear wave shaping: High pass, low pass RC circuits, their response for sinusoidal, step, pulse, square and ramp inputs.

Clippers and Clampers: Shunt Clippers, Series Clippers, Two-level Clippers, Positive and negative Clampers.

UNIT-II **[10 Periods]**

Operational amplifiers

OP-AMP and Applications: Block diagram of OP-AMP, ideal and practical characteristics of OP-AMP, Open and closed loop configurations of op-amps. Basic application of OP-AMP-Adders, Subtractors, Differentiators and Integrators, Comparators, Schmitt Trigger, Logarithmic amplifier, Sample and Hold circuit

UNIT-III **[10 Periods]**

Active Filters & Oscillators using Op-Amps:

Introduction, 1st order and higher order LPF, HPF filters, Band pass and Band reject filters Oscillator types and principle of operation – RC phase shift ,Wien-bridge and All Pass Filter .

UNIT IV **[10 Periods]**

Analog to Digital and Digital to Analog Converters:

Introduction, Basic DAC techniques, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Inverted R-2R DAC, Different Types of ADCs – Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC, Single slope and Dual Slope ADC, DAC and ADC Specifications..

UNIT-V **[10 Periods]**

Waveform Generators using Op-Amp & 555 Timers:

waveform generators – triangular and square wave , Monostable multivibrator using Op-Amp, Introduction to 555 timer, functional diagram, monostable and astable operations and applications, Voltage Controlled Oscillator(IC 566).

Text books:

1. Jacob Millman & Herbert Taub, "Pulse Digital & Switching Waveforms" McGraw-Hill Book Company Inc.
2. Linear Integrated Circuits, D. Roy Chowdhury, New Age International (p) Ltd.
3. Op-Amps & Linear ICs, Ramakanth A. Gayakwad, PHI.

Reference books:

1. Operational Amplifiers & Linear Integrated Circuits, R.F. Coughlin & Fredrick F. Driscoll, PHI.
2. Operational Amplifiers & Linear Integrated Circuits: Theory & Applications, Denton J. Daibey, TMH.
3. Digital Fundamentals – Floyd and Jain, Pearson Education

LINEAR CONTROL SYSTEMS

EEE 314	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO 1	BL-3	**Apply** signal flow graph and block diagram reduction techniques to **Develop** Transfer function for Linear time invariant systems.
CO 2	BL-3	**Apply** the relationship between the variables of electrical and mechanical systems to **Develop** mathematical models of electrical and mechanical systems.
CO 3	BL-4	**Analyze** the performance of 1st and 2nd order Linear time invariant systems with and without feedback control to **Determine** time domain specifications and error for standard inputs.
CO 4	BL-4	**Apply** Routh-Hurwitz criterion and Root locus technique to **Analyze** the stability for LTI systems in time domain frame.
CO 5	BL-4	**Apply** bode, polar and Nyquist plots to **Analyze** the stability for LTI systems in frequency domain frame.

Program Matrix

	Program Outcomes (POs)												**PSOs**	
COs	**Domain Specific Pos**					**Domain Independent Pos**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	1	1	1	-	-	-		-		2		2
CO 2	3	3	2		2	-	-	-		-		2		2
CO 3	2	2	3	1	2	-	-	-		-		2		2
CO 4	2	2	3		2	-	-	-		-		2		2
CO 5	2	2	3		2	-	-	-		-		2		2

JUSTIFICATION STATEMENT FOR CO-PO MAPPING			
COs	**POs**	**Level**	**Description**
1	1	3	The transfer functions of electrical systems are calculated using BDR and SFG techniques with the fundamental knowledge of basic electrical engineering and mathematics.
1	2	3	Transfer function is obtained by applying principles of mathematics and electrical engineering
1	3	1	Develop a block diagram and signal flow graph for a given electrical system
1	4	1	Investigation is performed on block diagram of a electrical system to obtain the transfer function
1	5	1	Using MATLAB, we can obtain the transfer function of given block diagram of a system.
1	12	2	Apply these methods of finding transfer functions to real time applications.
2	1	3	Find the transfer function of given mechanical system using basic principles of engineering mathematics
2	2	3	Modeling of electrical system from mechanical system (vice versa) using principles of engineering sciences
2	3	2	To develop complex electrical system from mechanical system using analogy techniques.
2	5	2	Modeling of electrical and mechanical systems using simulation software.
2	12	2	Modeling using analogy techniques can be applied to electro-mechanical systems
3	1	2	To obtain responses of given system by applying the knowledge of engineering mathematics
3	2	2	To determine error constants and steady state error of given system by applying mathematical and electrical engineering knowledge
3	3	3	Design of PI,PD,PID controller for a given system to meet the required performances.
3	4	1	To analyze the time domain specification for a complex problem
3	5	2	Using MATLAB,we can obtain a time domain specifications and response for a standard input
3	12	2	Recognize the need of finding the time response and time domain specifications to the advanced electrical system problems in any areas.
4	1	2	To determine the stability of a system using RH method by applying basic engineering knowledge
4	2	2	To determine the stability of a time system using root locus method by applying engineering knowledge.
4	3	3	Design of compensators using root locus techniques to meet the required stability conditions.
4	5	2	Using MATLAB, plot the root locus of a given system to find its stability
4	12	2	Recognize the need of time domain analysis to determine the stability of a given real time system under equilibrium conditions.

5	1	2	To obtain frequency domain specifications of given system by applying the knowledge of engineering mathematics
5	2	2	to determine the stability of a frequency domain system using bode plot method by applying engineering knowledge
5	3	3	Design of compensators using bode plot techniques to meet the required stability conditions.
5	5	2	Using MATLAB, plot the bode plot of a given system to find its stability
5	12	2	Recognize the need of frequency analysis to determine the stability of a given real time system under equilibrium conditions.

SYLLABUS

UNIT I: [10 Periods]

Transfer functions of linear systems-impulse response of linear systems-block diagrams of control systems-signal flow graphs-reduction techniques for complex block diagrams and signal flow graphs.

UNIT II: [8 Periods]

Introduction to mathematical modelling of physical systems-equations of electrical networks-modelling of mechanical systems- equations of mechanical systems.

UNIT III: [12 Periods]

Time domain analysis of control systems-time response of first and second order systems with standard input signals-steady state performance of feedback control systems-steady state error constants-effect of derivative and integral control on transient and steady state performance of feedback control systems.

UNIT IV: [10 Periods]

Concept of stability and necessary conditions for stability-Routh-Hurwitz criterion, relative stability analysis, the concept and construction of root loci, analysis of control systems with root locus.

UNIT V: [10 Periods]

Correlation between time and frequency responses - polar plots, **b**ode plots-log magnitude versus phase plots-all pass and minimum phase systems-Nyquist stability criterion-assessment of relative stability-constant M&N circles.

Text Books:

1. Control Systems Engineering by I.J. Nagrath& M.Gopal, Wiley Eastern Limited.
2. Automatic Control Systems by Benjamin C. Kuo, Prentice Hall of India.

Reference Book:

1. Modern Control Engineering by Ogata, Prentice Hall Of India.

PERFORMANCE OF INDUCTION AND SYNCHRONOUS MACHINES	
EEE 315	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

CO	BL	CO Statement
CO1	BL-3	**EXPLAIN** the working of 3-phase induction motor, generator & **ANALYZE** the performance charactiristics of 3-phase induction motor
CO2	BL-3	**DISCUSS** the working of 1-phase induction motor, other special motors & **ANALYZE** the performance charactiristics of 1-phase induction motor
CO3	BL-3	**EXPLAIN** the working of 3-phase alternator & **DETERMINE** the emf induced, regulation of alternator by different methods
CO4	BL-3	**ANALYZE** the synchronization process & parallel operation of alternators in detail.
CO5	BL-3	**EXPLAIN** the working of 3-phase synchronous motor & **DISCUSS** the effects of change in excitation & load on the machine when connected to infinite busbar.

Program Matrix

COs	Program Outcomes (POs)											PSOs	
	Domain Specific POs					Domain Independent POs							
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	1	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	1	-	-

JUSTIFICATION STATEMENT FOR CO-PO MAPPING			
COs	**POs**	**Level**	**Description**
CO1	PO1	3	The working of 3-phase Induction motor Including torque equations is **discussed** in detail by using **basic engineering fundamentals.**
CO1	PO2	3	With the help circle diagram efficiency **calculations** are made and the performance characteristics of 3-phase Induction motor are **analyzed**
CO1	PO12	1	Recognize the need for complete analysis of 3-phase induction machine for better exposure in manufacturing industry.
CO2	PO1	3	The working of 1-phase Induction motor & Other special motors is **discussed** in detail by using **basic engineering fundamentals.**
CO2	PO2	3	With the help of double field revolving theory the efficiency **calculations** are made and performance characteristics of 1-phase Induction motor is **analyzed.**
CO2	PO12	1	Recognize the need for complete analysis of 3-phase induction machine for better exposure in manufacturing industry.
CO3	PO1	3	The working of 3-phase alternator is **discussed** in detail using **electrical engineering fundamentals**
CO3	PO3	1	The **design** aspects of armature winding effecting the induced emf in the alternator is **discussed** in detail
CO3	PO12	1	Recognize the need for design aspects of armature winding for providing harmonic free electrical power.
CO3	PO2	3	The voltage regulation **calculations** of 3-phase alternator are made by using different techniques and henceforth the most accurate technique is concluded.
CO4	PO2	3	The parallel operation & synchronization of alternators is discussed & the effects of change in excitation & steam input on the operation is **analyzed**.
CO4	PO12	1	Recognize the need for complete analysis of 3-phase synchronous generator for better understanding of practical issues.
CO5	PO1	3	The working of 3-phase Synchronous motor Including starting techniques is **discussed** in detail by using **basic engineering fundamentals.**
CO5	PO2	3	The Motor behavior with change in excitation & load when connected to infinite is **analyzed** in detail.

SYLLABUS

UNITI: **[12 Periods]**

Induction Motor: Principle of operation of three phase induction motor, rotating magnetic field, types of rotor, torque expression, vector diagram, equivalent circuit and performance equations and calculations, slip-torque characteristic, circle diagram and performance calculations. Starting methods of induction motors, crawling and cogging, double squirrel cage induction motor, methods of speed control of induction motors, induction generator and principle of operation, self excitation of induction generator, Schrage motor, two phase motors. Linear induction motor-properties, magnetic levitation.

UNIT II: **[8 Periods]**

Single phase Induction Motors: Types of single phase induction motor, double revolving field theory, equivalent circuit, performance analysis and characteristics of capacitor start motors, shaded pole, repulsion type, reluctance, hysteresis and ac series motors.

UNIT III: **[10 Periods]**

Synchronous Generators: Basic Concepts, types of synchronous machines, construction, armature windings, emf equation, effect of chording and winding distribution, armature reaction, regulation by synchronous impedance, mmf and potier triangle methods.

UNIT IV: **[10 Periods]**

Synchronization: Parallel operation of synchronous generators, synchronizing current and synchronizing power. Synchronizing to infinite bus-bars and operation of infinite bus. Power transfer equations, capability curve, two reaction model of salient pole synchronous machine and power angle characteristics, determination of X_d and X_q by slip test, short circuit transients in synchronous machine.

UNIT V: **[10 Periods]**

Synchronous Motor: Principle of operation, methods of starting, power developed, effects of changing load at constant excitation, and changing excitation at constant load, excitation and power circles for synchronous machine, V – and inverted V – curves, hunting and damper windings.

Text Books:

1. D.P. Kothari, I.J. Nagarath, Electrical Machines, Tata Mac Graw Hill publication, 3rd edition, 2004.
2. Dr. P.S. Bhimbra, Electrical Machinery, Khanna publishers, 7th edtion, 2010.

Reference Books:

1. Dr. P.S. Bhimbra, Generalized theory of Electrical Machines, Khanna publishers, 4th edtion, 1987.

POWER TRANSMISSION & DISTRIBUTION	
EEE 316	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessionals Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-2	**Compare** various supply systems and **Determine** the most economical size of the conductor and **Estimate** the minimum voltage drop of distributors with concentrated loads.
CO2	BL-2	**Determine** the inductance and capacitance of solid, stranded and bundled conductors.
CO3	BL-3	**Analyze** the performance of short, medium and long transmission lines to **Determine** regulation and efficiency.
CO4	BL-3	**Calculate** the sag and tension of transmission tower supports at equal and unequal levels and **Determine** the string efficiency of suspended type insulators.
CO5	BL3	**Determine** the capacitance of single core and three core belted cables and **Calculate** the power loss due to corona.

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	-	-	-	-	-	-	-	1	2	-
CO2	2	3	2	-	-	-	-	-	-	-	-	1	3	-
CO3	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO4	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO5	2	3	2	-	2	-	-	-	-	-	-	1	3	-

JUSTIFICATION STATEMENT FOR CO-PO MAPPING			
COs	**POs**	**Level**	**Description**
CO1	PO1	2	Comparisons of various supply systems are made with the knowledge of fundamentals of basic electrical engineering and mathematics.
CO1	PO2	3	Analyze the most economical size of conductor with the Kelvin's law
CO1	PO3	1	Analyze the distribution calculations to design the voltage compensation at the low voltage bus
CO1	PO12	1	Recognize the need of distribution calculations in solving the advanced power distribution problems in the area of distribution power flows.
CO1	PSO1	2	Design the modern power distribution components and also solve the advances power distribution problems in the area of power distribution specialization using distribution power flow algorithms.
CO2	PO1	2	Develop the inductance and capacitance expressions for transmission lines with the knowledge of fundamentals of basic electrical engineering and mathematics.
CO2	PO2	3	Calculate the inductance and capacitance for 1-phase and 3-phase lines and analyze the effect of earth on inductance and capacitance calculations through

			method of images.
CO2	PO3	2	Design the phase impedance matrix and phase admittance matrix by considering the mutual coupling between the three-phase lines.
CO2	PO12	2	Recognize the need of inductance and capacitance calculations for exact modeling of three-phase lines in the area of power systems.
CO2	PSO1	3	Solve the parameters for bundle conductors and double circuit lines in the area of power system specialization with the knowledge of GMD and GMR.
CO3	PO1	2	Modeling of transmission lines and calculation of transmission parameters are made with the knowledge of basic electrical engineering and mathematics.
CO3	PO2	3	Analyze the short, medium and long transmission lines to determine the voltage regulation and efficiency.
CO3	PO3	2	Design the capacitor banks for reactive power compensation from the voltage regulation calculations
CO3	PO5	2	Using MATLAB software's the voltage regulation and efficiency are analyzed for the given transmission lines.
CO3	PO12	1	Recognize the of performance analysis of transmission lines in the area of power systems.
CO3	PSO1	3	Analyze the different types of transmission lines with the knowledge of transmission parameters.
CO4	PO1	2	Sag and tension expressions are derived with the knowledge of basic electrical engineering and mathematics.
CO4	PO2	3	Analyze the different methods to improve the string efficiency of suspension insulators. Analyze the sag on transmission line under bad weather conditions.
CO4	PO3	2	Design the height of tower to get required clearance from the ground under any weather conditions for equal and unequal level towers.
CO4	PO5	2	Using MATLAB software's the string efficiency and voltage distribution across the insulator disks are determined.
CO4	PO12	1	Recognize the need of mechanical design of transmission lines to determine the sag for ice coated lines and lines under wind pressure.
CO4	PSO1	3	Analyze the different methods for equalizing the potential distribution across the suspension insulators in overhead transmission system.
CO5	PO1	2	Construction of cables and insulation resistance and grading of cables are explained with the knowledge of basic electrical engineering and mathematics
CO5	PO2	3	Analyze the different grading methods to minimize the maximum stress on the insulation.
CO5	PO3	2	Analyze the experiments conducted on 3-core belted cable to determine its capacitance.
CO5	PO5	2	Design critical disruptive voltage and visual disruptive voltage under any weather conditions and for any conductor surface for overhead lines.
CO5	PO12	1	Recognize the need of bundle conductor configuration for reducing the power loss due to corona in EHV lines.
CO5	PSO1	3	Comparisons can be made between underground and overhead transmission and distribution of electrical power which will be helpful in the area of power system developments.

SYLLABUS

UNIT I: **[10 Periods]**

Electric Power Supply Systems: Single line diagram of A.C power supply system, comparison between A.C and D.C systems for transmission and distribution, comparison between various supply systems, effect of system voltage on transmission, choice of working voltage for transmission, economic size of conductor – Kelvin's Law.

Power Distribution Systems: Classification of distribution systems, types of distributors, D.C and A.C distributor calculations with concentrated loads. Necessity of neutral grounding, various methods of neutral grounding.

UNIT II: **[12 Periods]**

Transmission Line Constants: Inductance of a 1-ϕ, 2-wire line, inductance of composite conductors, concept of GMR & GMD, inductance of 3-ϕ symmetrical & unsymmetrical spaced transmission lines, transposition of power lines, inductance of double circuit 3-ϕ line, bundle conductors, skin effect & proximity effect.

Capacitance of 1-ϕ 2-wire line, capacitance of 3-ϕ symmetrical and unsymmetrical spaced transmission lines, capacitance of double circuit 3-ϕ line, effect of earth on transmission line capacitance.

UNIT III: **[12 Periods]**

Performance of Transmission Lines: Short transmission lines, medium length lines, long transmission lines, surge impedance, surge impedance loading, rigorous line modelling, equivalent T & π model of a long transmission line, Ferranti effect.

UNIT IV: **[8 Periods]**

Mechanical Design of Transmission Lines: Sag and tension calculations, supports at equal & different levels, effect of ice and wind, stringing chart, sag template, vibration and vibration dampers, conductor materials.

Over Head Line Insulators: Types of insulators, composite insulators, potential distribution across the string of insulators, string efficiency, methods of equalizing the potential.

UNIT V: **[8 Periods]**

Underground Cables: Comparison between over head & underground systems, types of cables, construction of cables, insulation resistance of cables, grading of cables-H.V &E.H.V, capacitance of 3-core belted cables.

Corona: Phenomenon of corona, critical voltages, power loss due to corona, factors effecting corona loss, radio interference.

Text books:

1. A Text Book on Power System Engineering by Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpatrai & Co, Ninth Edition, 2011.
2. Power System Engineering by D.P. Kothari, I. J. Nagrath, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition, 2008.
3. Electrical Power Systems' by C.L.Wadhwa, New Age International Publications, Sixth Edition, 2010.

Reference Books:

1. Electrical Power Systems by D. Das, New Age International Publications, 2010.
2. Transmission and Distribution of Electrical Power by J. B. Gupta, ', S.K. Kataria & sons publications, 2009.

ELECTRICAL MACHINES LABORATORY-I	
EEE 327	**Credits : 1.5**
Instruction : 3 Periods /Week	**Sessional Marks : 50**
End Exam : 3 Hours	**End Exam Marks : 50**

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

COs	BLs	CO Statement
CO1	BL-4	**Obtain** the OCC, Load and efficiency characteristics of DC generators and **Analyze** their performance.
CO2	BL-4	**Obtain** the regulation and efficiency characteristics of single phase transformer and **Analyze** their performance.
CO3	BL-4	**Obtain** the speed-torque and efficiency characteristics of DC motor and **Analyze** their performance.

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	3		1			1	1		1	0	1
CO2	2	3	1	3		1			1	1		1	0	0
CO3	2	3	1	3		1			1	1		1	1	0

S.No	Name of the Experiment	CO’s
1	Swinburne’s Test.	CO3
2	Load test on DC shunt motor.	CO3
3	Load test on DC series motor.	CO3
4	Speed control of DC shunt motor.	CO3
5	Speed control of DC series motor.	CO3
6	OCC & Load characteristics of DC shunt generator.	CO1
7	OCC & Load characteristics of DC separately excited shunt generator.	CO1
8	Load characteristics of DC compound generator.	CO1
9	Prediction of internal and external characteristics of a DC shunt generator.	CO1
10	Retardation Test.	CO1
11	Separation of losses in a DC machine.	CO3
12	Hopkinson’s Test.	CO1
13	OC & SC tests on a 1-phase Transformer.	CO2
14	Sumpner’s Test	CO2

ELECTRONICS LAB-II	
EEE 319	**Credits:1.5**
Instruction: 3 Practicals /week	Sessional Marks:50
End Exam: 3 Hours	End Exam Marks:50

Course Outcomes:

By the end of the course student should be able to:	
CO1	Design and verify the output of non-linear wave shaping circuits and linear wave shaping circuits for different inputs
CO2	Apply op-amps fundamentals in design and analysis of op-amps applications.
CO3	Design and analyse oscillator circuits and testing of Active LPF & HPF using op-amp
CO4	Verify the operation of A/D and D/A converters.
CO5	Design and analyze multivibrator circuits using op-amp and 555Timer

LIST OF EXPERIMENTS

Cycle 1:

1. Design *High pass* and *Low pass* RC circuits for different time constants and verify their responses for a square *wave* input of given frequency.
2. Design Clippers and Clampers circuit for moulding a waveform to a required shape.
3. Verify different applications of an Operational amplifier.
4. Verify different parameters of an operational amplifier.
5. Observe the working of an operational amplifier in inverting, non inverting modes.

Cycle 2:

1. Design and testing of Active LPF & HPF using op-amp.
2. Generate a sinusoidal signal using Wein bridge circuit.
3. Design of Schmitt Trigger using op-amp
4. Design of Astable multivibrator using a) op amp b) IC 555
5. Verify the operation of R-2R ladder DAC and flash type ADC.

Text books:

1. Jacob Millman, Christos Halkias, Chetan Parikh, "Integrated Electronics", 2nd Edition, McGraw Hill Publication, 2009.
2. Donald A. Neamon, “Electronic Circuit Analysis and Design”, 2nd Edition. TMG publications.

References:

1. Ramakanth A Gayakwad, “Op-Amps and Linear Integrated Circuits”- 4th Edition.

Professional Elective-II ELECTRICAL DRIVES AND TRACTION	
EEE 322	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes: At the end of the course, students will be able to:

CO	BL	CO Statement
CO1	BL-3	**CLASSIFY** the electric drives and **ANALYZE** their stability
CO2	BL-3	**MODIFY** speed torque characteristics of three phase induction motors, d.c. motors and synchronous motors.
CO3	BL-3	**ANALYZE** in detail the starting of dc & ac motors.
CO4	BL-3	**ANALYZE** electric braking in detail employed to dc & ac motors.
CO5	BL-3	**DETERMINE** the specific energy consumption for a particular run and **EXPLAIN** the factors affecting it.

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	1	-	-

JUSTIFICATION STATEMENT FOR CO-PO MAPPING			
COs	**POs**	**Level**	**Description**
CO1	PO1	3	The basics of electric drives using **basic sciences** & **fundamental engineering concepts** are discussed
CO1	PO2	3	The stability concepts were **discussed** in detail and henceforth the stability of electric drive is **analyzed** by using the same
CO2	PO2	3	The speed control techniques of electric motors are **analyzed** in detail.
CO2	PO3	1	The choice & **design** of appropriate circuit for obtaining a desired speed of an electric motor is **discussed.**
CO2	PO12	1	Recognize the need for complete analysis on speed control for better industrial application.
CO3	PO1	3	The starting techniques of electric motors are **discussed** in detail using **electrical engineering concepts**
CO3	PO2	2	The acceleration time & energy relations during starting are **analyzed** in detail for specific motor & load torques
CO3	PO12	1	Recognize the need for complete analysis of electrical starting for better industrial application.
CO4	PO1	3	The braking techniques of electric motors are discussed in detail using **electrical engineering concepts**

CO4	PO2	3	The energy relations during different electrical braking techniques & their dynamics are **analyzed** in detail.
CO4	PO12	1	Recognize the need for complete analysis of electrical braking for better industrial application.
CO5	PO1	3	The mechanics of electric traction are discussed in detail by electrical engineering concepts.

Professional Elective-II
DIGITAL CONTROL SYSTEMS

EEE 322	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes

At the end of the course, the student should able to

CO1	Identify the effects of sampling in performance
CO2	Apply sampled data system using difference equations, transfer function, block diagram
CO3	Analyse and design discrete control system using transform techniques
CO4	Analyze discrete time systems using signal flow graph and state space analysis
CO5	Explain the stability of sampled data signals

SYLLABUS

UNIT-I **[10 Periods]**

Signal Conversion and Processing: Introduction, block diagram representation of s/h device, mathematical modelling of the sampling process, effect of pole- zero placements , finite-pulse width sample, folding frequency. The sampling theorem, mathematical modelling of the sampling, ideal sampler, sample and hold devices, expressions of f*(s), s-plane properties of f*(s), zero-order hold, frequency-domain characteristics of zoh, first order hold, fractional hold device.

UNIT-II **[10 Periods]**

The Z-Transform: The Z-Transform Definition, Relationship With Laplace Transform, Alternate Expression For F(Z), Evaluation Of Z-Transform, Relationship Between S-Plane And Z-Plane, Inverse Z-Transform, Non Uniqueness Of The Z-Transform, The Inverse Z-Transform, Theorems Of The Z-Transform, Limitations Of The Z Transform.

UNIT-III **[10 Periods]**

Transfer Function, Block Diagrams & Signal Flow Graphs: Transfer functions, block diagrams, signal flow graphs, the pulse transfer function and z-transform function, systems with cascaded, elements separated by a sampler & not separated by a sampler, pulse transform function of zoh and relation between g(s) and g(z), closed loop systems, characteristic equation, physical reliability.

UNIT-IV **[10 Periods]**

The State Variable Techniques: State equations of discrete systems with sample and hold devices, state transition equations, the recursive method, the z-transform method, state equations and transfer function, characteristic equation, Eigen values, Eigen vectors, diagonalization of the “a” matrix, Jordan canonical form computing state transition matrix.

UNIT-V **[10 Periods]**

Controllability, Observability, Stability: Definition of controllability, theorem on controllability, definition of observability, theorem on observability, relationships between controllability and observability and transfer function, stability of linear digital control systems, definition & theorem, stability tests, bi-linear transformation method, jury's stability test. Detectability.

Text Books:

1 . Digital control systems by B.C. Kuo, second edition, Saunders college publication-1992.
2 . Digital Control Systems by Ogata.
3. Digital Control Systems (Software & Hardware) By Laymount & Azzo.

Professional Elective-II DIGITAL SIGNAL PROCESSING	
EEE 322	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes

At the end of the course, the student should able to

CO1	Acquired knowledge on different types of signals and properties of systems.
CO2	Apply Z - transforms and discrete time Fourier transforms to analyze a digital system.
CO3	Apply FFT for fast computation of DFT.
CO4	Design and realize IIR using different techniques.
CO5	Ability to design and realize FIR using different techniques.

SYLLABUS

UNIT I **[12 periods]**

Introduction to Digital Signal Processing & Applications of Z-Transforms: Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms, Applications of Z – transforms, solution of difference equations , Block diagram representation of linear constant-coefficient difference equations.

UNIT–II: **[12 periods]**

Discrete Fourier series and Discrete Fourier Transforms: Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT. Relation between Z–transform and DFS.

UNIT–III: **[12 periods]**

Fast Fourier Transforms: Frequency domain representation of discrete time signals and systems – Fast Fourier transforms (FFT) – Radix–2 decimation in time and decimation in frequency FFT Algorithms – Inverse FFT – and FFT for composite N.

UNIT IV: **[12 periods]**

IIR Digital Filter Design Techniques: Introduction, Analog low pass filter design, Butterworth and Chebyshev approximations, Frequency transformations, Design of HPF, Design of IIR Digital filter from analog filters, Bilinear Transformations method, Impulse invariance method. Realization of Digital filter: Direct form-I, Direct form-II, cascade form, Parallel form.

UNIT V: **[12 periods]**

FIR Digital Filter Design Techniques: Introduction, Fourier Series method to design digital filter, Design of FIR Digital Filters using Window Techniques, Frequency Sampling technique, Comparison of IIR & FIR filters.

Text Books:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI, 2007.

2. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006

3. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.

Reference Books:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006

2. Digital Signal Processing: MH Hayes, Schaum‟s Outlines, TATA McGraw Hill, 2007.

3. DSP Primer - C. Britton Rorabaugh, Tata McGraw Hill, 2005.

4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris,Thomson, 2007.

Professional Elective-III OPTIMIZATION TECNIQUES	
EEE 323	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes

At the end of the course, the student should able to

CO1	Formulate a linear programming problem and choose an appropriate method for obtaining an optimal solution.
CO2	Assess the minimum cost through transportation models and obtain the optimum solution
CO3	Assess the minimum cost through Assignment models.
CO4	Apply the concepts of PERT/CPM for decision making and computing the scheduled time of completion of a project.
CO5	Apply the game theory for optimization and finding the saddle point.

SYLLABUS

UNIT-I **[10 Periods]**

Introduction to Optimization: Engineering Applications of Optimization, Statement of Problem, Classification Of Optimization Problem Techniques.

Linear Programming : Introduction, Requirements For A Linear programming Problem, Examples On The Application Of Linear programming, Graphical Solution of 2-Variable Linear programming Problems, Some Exceptional Cases, General Mathematical Formulation For Linear programming problem, Canonical And Standard Forms Of Linear programming Problem, Simplex Method, Examples On The Application Of Simplex Techniques.

Artificial Variable Technique: Big-M Method and Two Phase Techniques.

UNIT-II **[10 Periods]**

Transportation Problem: Matrix Terminology, Definition and Mathematical Representation of Transportation Model, Formulation and Solution of Transportation Models (Basic Feasible Solution by North-West Corner Method, Inspection Method. Vogell"S Approximation Method)

UNIT-III **[10 Periods]**

Assignment Problem: Matrix Terminology, Definition of Assignment Model, Comparison With Transportation Model, Mathematical Representation Of Assignment Model, Formulation And Solution Of Assignment Models.

UNIT-IV **[10 Periods]**

Pert Network: Introduction, Phases Of Project Scheduling, Network Logic, Numbering The Events (Fulkerson'S Rule), Measure Of Activity.

Pert Network Computations: Forward Pass And Backward Pass Computations, Slack Critical Path, Probability Of Meeting The Scheduled Dates.

UNIT-V **[10 Periods]**

Game Theory: Useful Terminology, Rules For Game Theory, Saddle Point, Pure Strategy, Reduce Game By Dominance, Mixed Strategies, 2x2 Games Without Saddle Point.

TEXT BOOK:

1. "Operations Research" By S D Sharma.
2. "Operations Research" By R Panneerselvam
3. "Engineering Optimization-Theory & Practice" By S.S. Rao, New Age International (P) Ltd.
4. "Operations Research – An Introduction" By P.K.Gupta & D.S.Hira, S.Chnd & Co. Ltd.

Professional Elective-III
ELECTRICAL MACHINE DESIGN

EEE 323	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes

At the end of the course, the student should able to

CO1	Design of Armature winding, field winding & Armature slots.
CO2	Design the core dimensions and windings of Three phase and single phase Transformers.
CO3	Design the main dimensions, rotor & stator slots and air gap length of Induction and synchronous machines.

SYLLABUS

UNIT I **[10 Periods]**

Rating and Heating of Motors: Heating effects, loading conditions and classes of duty, determination of power ratings of motors for different applications, effect of load inertia, load equalization and fly wheel, calculations, environmental factors.

UNIT II **[10 Periods]**

D.C. Machines: E.M.F generated from full pitch - fractional pitch with and without distributed windings - distribution factor. Design of main dimensions from output equation - Design of Armature windings - Design of field system - Design of inter pole and commutator.

UNIT III **[10 Periods]**

Transformers: Derivation of output equation - volt per turn importance and calculation of main dimensions for three phase and single phase transformers - window dimensions – Yoke design and coil design - Design of tank with tubes.

UNIT IV **[10 Periods]**

Induction Motor: Derivation of output equation - calculation of main dimensions – Stator design - number of slots - shape and area of slots - Rotor design for squirrel cage and slip ring types.

UNIT V **[10 Periods]**

Synchronous Machines: Derivation of output equation - Calculations of Main Dimensions for salient pole and cylindrical rotor alternators - Stator design - number of stator slots and slot dimensions - Pole design for salient pole generators - pole winding calculations. Design of rotor for cylindrical rotor alternator - Design of rotor windings.

Text Books:

1. A.K. Sawhney, A Course in Electrical machine Design, Dhanpatrai & Sons,
2. M.G. Say,Performance and Design of AC Machines 3rd Edition.
3. A.E. clayton, Performance and Design of AC Machines 2004.

Professional Elective-III ANN & FUZZY SYSTEMS	
EEE 323	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

At the end of the course student should be able to:	
CO1	Explain the concepts of artificial neural networks.
CO2	Explain various learning methods in artificial neural networks.
CO3	Explain the concept of fuzziness involved in various systems and fuzzy set theory.
CO4	Analysis the applications of fuzzy logic controllers.
CO5	Acquire the knowledge on Fuzzy toolbox in Matlab software.

SYLLABUS

UNIT-I **[10Periods]**

Introduction to Artificial Neural Networks

Biological foundations, ANN models: Feed forward & Feedback Networks, Recurrent network, Types of activation functions. Network architectures: Single Layer Feed Forward Network (MLFFN) & Multi Layer Feed Forward Network (MLFFN), Characteristics of neural networks.

UNIT-II **[10Periods]**

Learning Process of Neural Networks

Learning process, Supervised and unsupervised learning, Error correction learning, Perceptron learning, Hebbian learning, Boltzmann learning, Single layer and multi layer perceptrons: Back propagation algorithm.

UNITIII **[10Periods]**

Introduction to Fuzzy Logic

Crisp sets, Properties of crisp sets, Fuzzy sets, operations of fuzzy sets, properties of fuzzy sets, The cardinality of fuzzy sets, Resolution identity, Convex fuzzy sets, crisp and Fuzzy Relations, Fuzzy arithmetic, Membership functions, Fuzzy to crisp conversion, Fuzzification and defuzzification methods, fuzzy inference, fuzzy rule base system.

UNITIV **[10Periods]**

Fuzzy Control & Applications

Fuzzy control systems, Fuzzy logic controller application to: Automatic remote control for television set, Inverted pendulum, air conditioner control, simple momentum model for aircraft landing, automatic washing machine system.

UNITV **[12Periods]**

Matlab implementation of fuzzy system:

Fuzzy Logic Toolbox in MATLAB, GUI of Fuzzy Toolbox, Fuzzy inference system, Membership Function Editor, Editing input and output membership functions, Fuzzy logic operations, Triangular Norm, Mapping, Fuzzy reasoning.

Texts Books:

1. “Neural Network, Fuzzy Logic & Genetic Algorithm”, S. Rajasekaran, G.A.Vijayalakshmi Pai, PHI publications, 2007.
2. “Artificial Neural Networks”, Bose &Liang, Tata McGraw-Hill, 1996.
3. “Neural Networks: A Comprehensive Foundation”, Simon Haykins, Pearson Education, Asia, 2nd edition.
4. “Fuzzy Logic with Engineering Applications”, Timothy J. Ross, McGraw hill, New York, 2nd edition.

Reference Books:

1. “An introduction to neural networks”, Ben Krose &P. Vander Smagt, nov.1996, 8th edition.
2. “Fuzzy Set Theory and its Applications”, H.J. Zimmermann, Kluwer Academic Publishers, London, 3rd edition.
3. “Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications”, Stamatios V Kartalopoulos, Prentice Hall of India (P) Ltd., New Delhi, 2000.

POWER ELECTRONICS	
EEE 324	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Discuss** thyristor operation and characteristics to **calculate** ratings and design parameters of thyristors.
CO2	BL-4	**Illustrate** the commutation circuits, triggering circuits & series-parallel operation of thyristors to **Select** the appropriate circuit & connection for a particular application of thyristor/thyristors.
CO3	BL-3	**Demonstrate** the operation and waveforms of phase controlled rectifiers to **Compute** the performance parameters of rectifiers.
CO4	BL-3	**Classify** various types of inverters to **Examine** their use in specific applications.
CO5	BL-3	**Illustrate** the operation of DC Choppers & AC to AC Converters to **Utilize** these converters for electric drive applications, **Summarize** the operation and characteristics of DIAC & TRIAC

Program Matrix

COs	**Program Outcomes (POs)**												**PSOs**	
	Domain Specific POs					**Non-Domain Independent POs**								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	1	-	2
CO2	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO3	2	3	1	-	2	-	-	-	-	-	-	1	-	2
CO4	2	3	-	-	2	-	-	-	-	-	-	1	-	2
CO5	2	3	-		2	-	-	-	-	-	-	1	-	2

JUSTIFICATION STATEMENT FOR CO-PO MAPPING			
COs	**POs**	**Level**	**Description**
CO1	PO1	2	Thyristor construction, operation and performance characteristics are illustrated with the knowledge of basic engineering sciences and fundamental engineering.
CO1	PO2	2	Based on the specified limits of an individual thyristor, the snubber circuit parameters are calculated and results are analyzed based on thyristor ratings.
CO1	PO3	1	Design the protection circuit of a thyristor for a given application .
CO1	PO12	1	Recognize the need of thyristor knowledge in terms of their performance, characteristics and protection, in order to be compatible enough for high power drive and high power converter application based industries.
CO2	PO1	2	The fundamental knowledge of basic engineering mathematics, engineering physics and electrical engineering is utilized for demonstrating firing circuit designs and series-parallel thyristor operation.
CO2	PO2	3	Based on the knowledge of commutation circuits and thyristor firing circuits, design of circuit parameters are analyzed and their values are calculated.
CO2	PO3	1	The classification and basic configuration knowledge of firing circuits and commutation circuits of thyristor is utilized for designing thyristor based converter design based applicability.
CO2	PO5	2	Using MATLAB software the performance specifications of commutation circuits of thyristor is analyzed .
CO2	PO12	1	Recognize the need of auxiliary circuitary for thyristors, in order to be compatible enough for high power drive and high power converter application based industries.
CO2	PSO2	2	With the knowledge of circuit requirement for performing switching operation of thyristors, as per the requirement and availability, thyristor based power converters are analyzed.
CO3	PO1	2	With the knowledge of fundamental electrical engineering and engineering mathematics, rectifier operation, waveform and performance characteristics are demonstrated.
CO3	PO2	3	In reference to various rectifier configurations, mathematical derivations of output voltage are formulated and their performance parameters are computed.
CO3	PO3	1	Design rectifier circuits considering the practical effect of source inductance on rectifier performance.
CO3	PO5	2	Using MATLAB/SIMULINK software the operational performance of various rectifier configurations are analyzed.
CO3	PO12	1	Recognize the need of rectifier configuration design as per the requirement, since rectifiers are one of the most common power electronic device being implemented from low power level to high power level applications.
CO3	PSO2	2	With the knowledge of rectifier operation and characteristics, power electronic based applications such as electric drives are analyzed.
CO4	PO1	2	The fundamental knowledge of basic engineering science, engineering mathematics are utilized for analyzing output voltage expressions of inverter using fourier analysis .
CO4	PO2	3	With knowledge of different inverter configurations, their application criteria in specific applications are formulated and performance parameters are analyzed.
CO4	PO5	2	Using MATLAB/SIMULINK software, inverter circuit configurations are virtually tested to analyze their performance specifications.
CO4	PO12	1	Recognize the need of inverter configuration and suitability knowledge, as per its application, since inverter as a power electronic device constitutes a common

			component of any electric drive system, used in industrial and research sector.
CO4	PSO2	2	With the knowledge of inverter operation and characteristics, appropriate switching device applicability is analyzed, based on power and frequency rating of the inverter.
CO5	PO1	2	With the knowledge of fundamental electrical engineering and engineering mathematics, DC choppers & AC-AC converters operation, waveform and performance characteristics are demonstrated.
CO5	PO2	3	For different chopper configurations, mathematical derivations of output voltage are formulated and their performance parameters are computed.
CO5	PO5	2	Using MATLAB/SIMULINK software the operational performance of various chopper and converter configurations are analyzed.
CO5	PO12	1	Recognize the need of DC-DC converter and AC-AC converter configuration design knowledge, since DC-DC converters plays a vital role in designing power supply unit in electrical and electronic devices and AC-AC converters are highly useful in electric drive applications.
CO5	PSO2	2	With the knowledge of various DC and AC converter operation and characteristics, their role in applications like electric drives for industrial and research sectors are analyzed.

SYLLABUS

UNIT I: **[8 Periods]**

Thyristors: Introduction, principle of operation, two transistor model, static V-I characteristics, dynamic characteristics, gate characteristics, turn on methods, thyristor ratings, measurement of thyristor parameters, protection circuits.

UNIT II: **[12 Periods]**

Gate Triggering Circuits and Commutation Circuits: Resistance firing, resistance-capacitor firing, UJT triggering, class A, class B, class C, class D, class E, class F commutation circuits.

Series and Parallel Operation of Thyristors: Equalizing networks, string efficiency, derating.

UNIT III: **[10 Periods]**

Phase Controlled Rectifiers: Single phase -half wave, full wave & bridge controlled rectifiers. Three phase half wave and full wave controlled rectifiers, three phase fully controlled bridge rectifier effect of source inductance on single phase and three phase converters.

UNIT IV: **[10 Periods]**

Inverters: Classification, voltage source inverters, current source inverters, the Mc-Murray inverter, series and parallel inverters,

UNIT V: **[10 Periods]**

Choppers: Principle of operation, step-up, step-down choppers, two quadrant type A chopper, four quadrant chopper, Jones chopper, Buck converter, Boost Converter and Buck-Boost converter, AC voltage controllers R, R-L loads.

Cyclo Converters: Principle of operation, single phase to single phase Cycloconverter. Principle of operation and static characteristics of Diac & Triac.

Text Books:

1. Power Electronics by Dr. P.S. Bimbra, 4th Edition, 2012, Khanna Publishers.
2. Power Electronics by M.D. Singh, K.B. Khanchandani, 2nd edition, 2006,Tata McGraw –Hill Publishing Company Limited.

Reference Books:

1. Power Electronics, Circuits, Devices & Applications by Muhammad H Rashid, 4th Edition, 2003, Pearson Education.
2. Power Electronics for Technology by Ashfeq Ahmed, Prentice hall Education, 1998.

POWER SYSTEM ANALYSIS	
EEE 325	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

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

CO	BL	CO Statement
CO1	BL-3	**Apply** per unit calculations to **Develop** reactance diagram for a given single line diagram.
CO2	BL-3	**Apply** Gauss-Seidel, Newton-Raphson and Fast Decoupled methods to **Compute** different parameters of the load flow problem.
CO3	BL-4	**Analyze** symmetrical and unsymmetrical faults to **Compute** fault current of the given single line diagram.
CO4	BL-4	**Analyze** the steady state and transient stability on single machine connected to infinite bus system to **Determine** steady state and transient stability limit.

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	-	-	-	-	-	-	-	-	1	2	-
CO2	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO3	2	3	2	-	2	-	-	-	-	-	-	1	3	-
CO4	2	3	2	-	2	-	-	-	-	-	-	1	3	-

JUSTIFICATION STATEMENT FOR CO-PO MAPPING			
COs	**POs**	**Level**	**Description**
CO1	PO1	2	Per unit values are calculated with the knowledge of fundamentals of basic electrical engineering and mathematics.
CO1	PO2	3	Based on the per unit values, formulate the impedance diagram and analyze it and develop the reactance diagram.
CO1	PO3	1	Calculate the ratings/design parameters of the various electrical equipment's with the knowledge of per unit calculations.
CO1	PO12	1	Recognize the need of per unit calculations for solving the advanced power system problems in the area of power system specialization.
CO1	PSO1	2	Design the modern power system components and also solve the advances power system problems in the area of power system specialization using per unit calculations.
CO2	PO1	2	Develop the bus admittance matrix with the knowledge of fundamentals of basic electrical engineering and mathematics.
CO2	PO2	3	Calculate voltage magnitude, phase angles, real power flows, reactive power flow, and line losses and analyze the single line diagram using different load flow methods with help of bus admittance matrix.
CO2	PO3	2	Design power system components through simulation software's with the knowledge of load flow parameters like voltage magnitude, phase angles, real power flows, reactive power flow, and line losses.
CO2	PO5	2	Using ETAP/MATLAB software's the load flow parameters like voltage magnitude, phase angles, real power flows, reactive power flow, and line losses

			are calculated and analyzed for the given single line diagram.
CO2	PO12	2	Recognize the need of load flow calculation for solving the advanced power system problems in the area of power system specialization.
CO2	PSO1	3	Solve the advanced power system problems like congestion management, optimal power flow etc in the area of power system specialization with the knowledge of load flow studies.
CO3	PO1	2	Form the bus impedance matrix with the knowledge of fundamentals of basic electrical engineering and mathematics.
CO3	PO2	3	For the given electrical network using bus impedance matrix and the knowledge of basic electrical circuit theorems fault currents are calculated and also the same is analyzed for symmetrical and unsymmetrical type of faults.
CO3	PO3	2	Ratings/design parameters of the Circuit Breaker and fault limiting reactors are calculated based on the analysis of different types of faults.
CO3	PO5	2	Using ETAP/MATLAB software's the symmetrical and unsymmetrical faults are calculated and analyzed for the given single line diagram.
CO3	PO12	1	Recognize the need of fault current calculations for design of protective equipment and security aspects of power system.
CO3	PSO1	3	Solve the advanced power system problems like contingency analysis, power system security, state estimation etc. with the knowledge of fault calculations.
CO4	PO1	2	Derive the swing equation and as well as concept equal area criteria with the knowledge of basic electrical engineering and mathematics.
CO4	PO2	3	With the knowledge of swing equation/equal area criteria, the steady state and transient stability are analyzed under different disturbances for the single machine connected to infinite bus system.
CO4	PO3	2	Design the rating of the Circuit breakers with calculations of transient stability parameters like critical clearing angle and critical clearing time.
CO4	PO5	2	Using MATLAB software's the transient stability parameters like critical clearing angle and critical clearing time are calculated and analyzed for the given single line diagram.
CO4	PO12	1	Recognize the need of transient stability analysis to design the modern protective equipment under different disturbances.
CO4	PSO1	3	Calculate voltage, frequency and rotor angle stability for a multi-machine system with the knowledge of transient stability analysis.

SYLLABUS

UNIT-I **[8 Periods]**

Per Unit System of Representation

Single line diagram, per unit system, per unit impedance of a 3-winding transformer, per unit impedance and reactance diagram of a power system.

UNIT-II **[12 Periods]**

Power Flow Analysis

Formulation of bus admittance matrix, classification of buses, power flow problem, Gauss-Seidel Method, Newton-Raphson method, Decoupled & Fast decoupled method of solving power flow problem.

UNIT-III **[10 Periods]**

Symmetrical Fault Analysis

Formulation of bus impedance matrix, 3-phase short circuit currents and reactance of a synchronous machine, methods of calculating symmetrical fault currents, selection of circuit-breakers, fault limiting reactors.

UNIT-IV **[10 Periods]**

Un-Symmetrical Fault Analysis

Symmetrical components, 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, phase shift in delta/star Transformers.

Unsymmetrical faults –L-G, L-L, L-L-G on an unloaded alternator.

UNIT-V **[10 Periods]**

Power System Stability

Concepts of stability (steady state and transient), swing equation, steady state stability limit, equal area criterion, critical clearing angle and time for transient stability, step by step method of solution, methods of improving transient stability. Introduction to voltage stability.

Text Books:

1. Power System Analysis by Hadi Sadat, TMC Publications, 3rd edition, 2010.
2. Elements of Power System Analysis by John J. Grainger & William D. Stevenson, Jr.TMH Publications, 2014.
3. Modern Power System Analysis by I.G. Nagrath & D.P. Kothari, TMH Publications, 4th edition, 2011.

Reference Books:

1. Electric Power Systems by B. M. Weedy & B. Cory, Wiley Publications, 4th edition, 2012.
2. Power System Analysis &Design Systems by J. Duncan Glover, M.S.Sarma & Thomas J. Overbye, CLI Private Ltd., 2012.

ADVANCED CONTROL SYSTEM	
EEE 326	**Credits : 3**
Instruction : 2 Periods & 1 Tut/Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

At the end of the course student should be able to

CO1	Develop the mathematical model for any electrical and mechanical systems.
CO2	Develop the state model and identify its stability of the given electrical and mechanical systems.
CO3	Observe the effect of a controller to improve the time response.
CO4	Design a compensator to improve the response.

SYLLABUS

UNIT-I: **[10 Periods]**

Control Systems Components: D.C & A.C. tachometers, synchros, A.C. and D.C. servo motors-stepper motors and its use in control systems, amplidyne – metadyne - magnetic amplifier–principle, operation and characteristics – ward – leonard system.

UNIT –II: **[10 Periods]**

State Variable Analysis: Concept of state variables & state models, state model for line a continuous time systems, solution of state equation, state transition matrix.

UNIT-III: **[10 Periods]**

Concept of controllability & observability (simple problems to understand theory), pole placement by state feedback method, design of state feedback controller.

UNIT-IV: **[10 Periods]**

Introduction and effect of proportional (P), Proportional plus Integral (PI), Proportional plus Derivative (PD), Proportional plus Integral plus Derivative (PID) controller and finding the system response.

UNIT-V: **[10 Periods]**

Introduction to lag, lead, lag-lead compensating networks and realization of networks. Design of lag, lead and lag-lead compensators by using Root locus technique, design of lag, lead, lag-lead compensators by using Bode plot method.

Text Books:

1. Control Systems Engineering by I.J. Nagrath and M.Gopal, New Age International Publications.
2. Control systems components by G.J. Gibson Tuetor, ‘.
3. Automatic control systems by B.C. Kuo, Prentice Hall of India, 1988.

Reference Books:

1. Modern Control Engineering by Ogata K., 4th Edition, Prentice Hall
2. System Dynamics by Ogata K. 3rd Edition, Prentice Hall
3. Control Systems Principles and Design by M. Gopal, 2nd Edition, Tata McGraw Hill
4. Control Systems Engineering by Norman S. Nise, 3rd Edition, Wiley
5. Control System Design Guide – A Practical Guide by George Ellis,3rd Edition, Academic Press

CONTROL SYSTEM LABORATORY

EEE 328	Credits : 1.5
Instruction : 3 Periods Week	Sessional Marks : 50
End Exam : 3 Hours	End Exam Marks : 50

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

COs	BLs	CO Statement
CO 1	BL- 4	**Obtain** the speed-torque characteristics of DC and A.C Servo motors and **Analyze** their performance.
CO 2	BL- 4	**Obtain** the characteristics of Synchro, BLDC motor, DC position control system and Magnetic amplifier and **Analyze** their performance.
CO 3	BL- 4	**Analyze** the response of 1^{st}, 2^{nd} and 3^{rd} order systems with and without feedback and **Compare** their waveforms graphically for different input signals.
CO 4	BL- 4	**Design** the compensators and **Determine** their stability using Bode plot techniques.
CO 5	BL- 4	**Estimate** the effect of Temperature control system and **Compare** with and without controllers

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	3		1	-	-	1	1	-	1	0	1
CO2	2	3	1	3		1	-	-	1	1	-	1	0	1
CO3	2	3	1	3		1	-	-	1	1	-	1	0	1
CO4	2	3	1	3		1	-	-	1	1	-	1	0	1
CO5	2	3	1	3		1	-	-	1	1	-	1	0	1

S.No	Name of the Experiment	CO's
1	Study of Lead, Lag and Lead-Lag compensating networks.	CO4
2	Speed - Torque characteristics of a DC Servomotor.	CO1
3	To study the 'Magnetic Amplifier'.	CO2
4	Linear system simulator	CO3
5	Speed torque characteristics of A.C. Servo motor	CO1
6	Synchro transmitter and receiver pair	CO2
7	DC Motor Speed control characteristics	CO1
8	To study the D.C Position control system	CO2
9	To study the temperature controller using P, PI, PD and PID modes of operation	CO5
10	To study the performance of BLDC motor	CO2

ELECTRICAL MACHINES LABORATORY-II	
EEE 329	**Credits : 1.5**
Instruction : 3 Periods Week	**Sessional Marks : 50**
End Exam : 3 Hours	**End Exam Marks : 50**

Course Outcomes:

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

COs	BLs	CO Statement
CO1	BL-4	**Analyze** the performance of transformer for 3 phase to 2 phase or 2 phase to 3 phase conversion and **Separate** the core losses.
CO2	BL-4	**Obtain** the speed control characteristics and efficiency characteristics of 3 phase induction machine and **Analyze** their performance.
CO3	BL-4	**Synchronize** 3phase alternator with supply, **Obtain** voltage regulation characteristics and **Analyze** their performance.

Program Matrix

COs	Program Outcomes (POs)												PSOs	
	Domain Specific POs					Domain Independent POs								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	1			3	-			2	0
CO2	2	3	3	3	2	2			3	1			0	2
CO3	2	3	3	3	2	2			3	1			2	0

S.No	Name of the Experiment	CO's
1	Verification of Scott connection.	CO1
2	Load test on a 3-phase Induction motor.	CO2
3	No load and Block rotor tests on 3-phaseInduction motor.	CO2
4	Speed control of 3-phase Slip-ring Induction motor.	CO2
5	Regulation of an alternator by EMF and MMF methods.	CO3
6	Regulation of an alternator by ZPF method.	CO3
7	V and Inverted V Curves of Synchronous motor.	CO3
8	Slip test on Salient pole Synchronous machine.	CO3
9	3-phase Induction motor runs as a 1-phaseInduction motor.	CO3
10	R-L-C Load Test on a 1-phaseTransformer.	CO1
11	Equivalent circuit of a 1-phase Induction motor.	CO2
12	Line-excited Induction generator.	CO2
13	Separation of losses in single phase transformer.	CO1

Open Elective-I (Not for EEE) UTILIZATION OF ELECTRICAL ENERGY	
EEE	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

At the end of the course student should be able to

CO1	Explain basic concepts of traction system.
CO2	Explain different types of heating methods.
CO3	Explain different types of welding methods.
CO4	Explain different types of lighting methods.
CO5	Explain different types of tariff structure.

SYLLABUS

UNIT I

Electric Traction: System of electric traction and track electrification, Review of existing electric traction systems in India, Mechanics of train movement, Speed-time curves for different services – trapezoidal and quadrilateral speed time curves, traction effort, power, specific energy consumption, effect of varying acceleration and braking, retardation, adhesive weight and braking retardation, coefficient of adhesion

UNIT II

Electric Heating: Classification of electric heating methods, resistance heating, induction heating, dielectric heating, high frequency eddy current heating.

UNIT III

Electric Welding: Electric welding, resistance welding, arc welding, ultrasonic welding, laser beam welding, comparison between A.C. and D.C. Welding.

UNIT IV

Illumination: Introduction, terms used in illumination, laws of illumination, polar curves, sources of light, Arc lamps, Incandescent lamps, Gaseous Discharge lamps, comparison between tungsten filament lamps and fluorescent tubes, Types and design of lighting.

UNIT V

Economic Considerations: Economics of power generation, significance of load factor & diversity factor, base load plants, peak load plants, load sharing between base load and peak load plants, Tariff, types of tariffs

Text Books:

1. Utilization of Electric Energy – by E. Open Shaw Taylor, Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab, Dhanpat Rai & Sons.

Reference Books:

1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy – by C.L. Wadhwa, New Age International (P) Limited, Publishers, 1997.

Open Elective-II (Not for EEE) NON CONVENTIONAL ENERGY SOURCES	
EEE	**Credits : 3**
Instruction : 3 Periods & Week	**Sessional Marks : 40**
End Exam : 3 Hours	**End Exam Marks : 60**

Course Outcomes:

At the end of the course student should be able to

CO1	Acquire knowledge on the Non-Conventional Energy Sources related to electrical and electronics engineering.
CO2	Acquire knowledge about the fundamental principles of Solar Energy, Wind Energy, energy from Oceans etc.
CO3	Acquire knowledge on the Non-Conventional Energy Sources.
CO4	Acquire and establish on the small Bio-Gas Energy Power Plant in home.
CO5	Apply the acquired knowledge in Non-Conventional Energy Sources for the benefit of the society.

SYLLABUS

UNIT I **[10 Periods]**

Solar Energy: Introduction to conventional, non-conventional energy sources, advantages and disadvantages. Basic principle of solar energy, solar radiation, solar collectors, applications, advantages and limitations. Introduction to Photovoltaic cells, PV module and PV array, Maximum power point tracking system.

UNIT II **[10 Periods]**

Wind Energy: Basic principles, components of wind energy conversion system (WECS), classification of WECS, applications, advantages and limitations.

UNIT III **[10 Periods]**

Bio-Energy: Introduction, difference between bio-mass and bio-gas, biomass-energy conversion, wet & dry process, classification of biogas plants, constructional details of few main digesters, biogas from wastes, applications.

UNIT IV **[10 Periods]**

Geo-Thermal Energy: Introduction, sources, prime movers for Geo-Thermal Energy, Applications.

Energy from the Oceans: Introduction, ocean-thermal electrical conversion (OTEC), open and closed cycles. Tidal energy principles, single and double basin arrangements, wave energy conversion devices.

UNIT V **[10 Periods]**

Fuel Cells: Introduction, classification, types, conversion efficiency, applications. Introduction to Wind-Diesel Hybrid System, Wind-Photovoltaic Hybrid System.

Texts Books:

1. Non-Conventional Energy Sources by G.D. Rai, Khanna Publications.

Reference Books:

1. Non- Conventional Energy Resources by B.H. Khan by Tata McGraw- Hill.
2. Energy Technology Non-Conventional, Renewable & Conventional by S. Rao.
3. Future sources of electrical power by M.P. Agarwal First Edition, S. Chand & Co, 1999.