Under Graduate Course Structure

For

Electrical & Electronics Engineering

(Applicable for batches admitted from 2020-2021)

S No	Programme Code	Programme Name	Specialization	No. of Sections	No. of Students
1	02	B. Tech	Electrical & Electronics Engineering	01	60

Autonomous Regulations – AR20

Amrita Sai Institute of Science & Technology

Approved by AICTE, New Delhi; Permanently Affiliated to JNTUK, Kakinada
ISO 9001:2015 Certified Institution; Accredited by NAAC with "A" grade
Recognized by UGC under 2(f) and 12(B) of UGC 1956 Act
Amrita Sai Nagar, Paritala, Krishna District Andhrapradesh – 521 180
www.amritasai.edu.in, 0866-2428399

AMRITA SAI INSTITUTE OF SCIENCE AND TECHNOLOGY
(AUTONOMOUS)

Approved by AICTE, New Delhi; Permanently Affiliated To JNTU, Kakinada
ACCREDITED BY NAAC WITH "A" GRADE
PARITALA(P), KANCHIKACHERLA(M), KRISHNA (D)–521 180(A. P.)

DEPARTMENT OF ELECTRICAL& ELECTRONICS ENGINEERING

COURSE STRUCTURE FOR AR20 REGULATION

I YEAR I SEMESTER:

SNO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
1	20BS1T1	Engineering Physics	BSC	3	0	0	3
2	20BS1T2	Ordinary Differential Equations & Calculus	BSC	3	0	0	3
3	20ES1T3	Electrical Circuit Analysis	ESC	3	0	0	3
4	20ES1T4	C Programming	ESC	3	0	0	3
5	20ES1T5	Engineering Graphics And Design	ESC	1	0	4	3
6	20BS1L1	Engineering/Applied Physics Lab	BSC	0	0	3	1.5
7	20ES1L2	C Programming Lab	ESC	0	0	3	1.5
8	20ES1L3	Engineering workshop & ITWS Lab	ESC	0	0	3	1.5
9	20MC1T6	Environmental Studies	MC	**2**	**0**	**0**	**0**
TOTAL CREDITS							**19.5**

I YEAR II SEMESTER:

S.NO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
1	20HS2T1	Communicative English-I	BSC	3	0	0	3
2	20BS2T2	Linear Algebra & Transformations	BSC	3	0	0	3
3	20BS2T3	Engineering Chemistry	ESC	3	0	0	3
4	20ES2T4	Python Programming	ESC	3	0	0	3
5	20ES2T5	Engineering Mechanics	ESC	3	0	0	3
6	20HS2L1	Communicative English Lab	BSC	0	0	3	1.5
7	20BS2L2	Engineering Chemistry Lab	ESC	0	0	3	1.5
8	20ES2L3	Python Lab	ESC	0	0	3	1.5
TOTAL CREDITS							**19.5**

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II YEAR I SEMESTER:

SNO	SUB CODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
1	20BS3T1	Numerical Methods & Complex Variables	BS	3	0	0	3
2	20EE3T2	Electrical Circuit Analysis - II	EE	3	0	0	3
3	20EE3T3	Electrical Machines-I	EE	3	0	0	3
4	20BE3T4	Electronic Devices & Circuits	EE	3	0	0	3
5	20EE3T5	Power Systems-I	EE	3	0	0	3
6	20EE3L1	Electrical Circuits Laboratory	EE	0	0	3	1.5
7	20EE3L2	Electrical Machines -I Laboratory	EE	0	0	3	1.5
8	20EE3L3	Electronic Devices & Circuits Laboratory	EE	0	0	3	1.5
9	20EE3T6A	Electrical Safety	SE	1	0	2	2
	20EE3T6B	Data Analytics-I					
	20EE3T6C	Cloud Computing-I					
	20EE3T6D	Web & Mobile Development-I					
	20EE3T6E	Cyber Security-I					
10	20EE3T7	Essence of Indian Traditional Knowledge	MC	2	0	0	0
	TOTAL CREDITS						**21.5**

II YEAR II SEMESTER:

SNO	SUBCODE	COURSE TITLE	CATEGORY	L	T	P	CREDITS
1	20EE4T1	Electromagnetic Fields	ES	3	0	0	3
2	20EE4T2	Control Systems	EE	3	0	0	3
3	20EE4T3	Power Systems-II	EE	3	0	0	3
4	20EE4T4	Electrical Machines-II	EE	3	0	0	3
5	20HS4T5	Communicative English-II	HS	3	0	0	3
6	20EE4L1	Communicative English-II Lab	ES LAB	0	0	3	1.5
7	20EE4L2	Electrical Machines-II Laboratory	EE LAB	0	0	3	1.5
8	20EE4L3	Control Systems Lab	EE LAB	0	0	3	1.5
9	20EE4T6A	Robotics And Humanoids	SE	**1**	**0**	**2**	**2**
	20EE4T6B	Data Analytics-II					
	20EE4T6C	Cloud Computing-II					
	20EE4T6D	Web & Mobile Development-II					
	20EE4T6E	Cyber Security-II					
			TOTAL CREDITS				**21.5**
Internship 2 Months (Mandatory) during summer vacation							

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Course Code 20ES1T3	ELECTRICAL CIRCUIT ANALYSIS-I	L 3	T 1	P --	C 3

PURPOSE: This course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the Electrical Engineering discipline. The emphasis of this course is laid on the basic analysis of circuits which includes single phase circuits, magnetic circuits, network theorems, transient analysis and network topology.

COURSE OBJECTIVES	
1	To study the concepts of passive elements, types of sources and various network reductiontechniques.
2	To understand the applications of network topology to electricalcircuits.
3	To study the concept of magnetic coupledcircuit.
4	To understand the behaviour of RLC networks for sinusoidalexcitations.
5	To study the performance of R-L, R-C and R-L-C circuits with variation of one of the parameters and to understand the concept ofresonance.
6	To understand the applications of network theorems for analysis of electrical networks.
COURSE OUTCOMES: Students are able to	
1	Solve Various electrical networks in presence of active and passiveelements.
2	Understand network topologyconcepts.
3	Solve any magnetic circuit with various dotconventions.
4	Analyse R, L, C network with sinusoidalexcitation.
5	Plot locus diagrams for sires R-L&R-C Circuits.
6	Solve any electrical network by Network theorems

UNIT-I: Introduction to Electrical Circuits: Passive components and their V-I relations. Sources (dependent and independent) -Kirchoff's laws, Network reduction techniques(series, parallel, series - parallel, star-to-delta and delta- to-star transformation). Source transformation technique, nodal analysis and mesh analysis, Super Mesh, Super Node.

UNIT-II: Single Phase A.C Systems: Periodic waveforms (determination of rms, average value,Peak factor and form factor).Concept of phase angle and phase difference – Waveforms and phasor diagrams for lagging, leading networks. Complex and polar forms of representations, steady state analysis of R, L and C circuits. Power Factor and its significance Real, reactive power and apparent power, power triangle and complex power.

UNIT-III: Analysis of AC Networks: Extension of node and mesh analysis to AC networks, Numerical problems on sinusoidal steady state analysis, Series and parallel resonance, Selectively band width and Quasi factor, Introduction to locus diagram. *Series R-L , R-C Circuits*

UNIT-IV: Magnetic Circuit: BasicdefinitionofMMF,fluxandreluctance.Analogybetweenelectrical and magnetic circuits.Faraday's laws of electromagnetic induction, Concept of self and mutual inductance.Dot convention-coefficient of coupling and composite magnetic circuit.Analysis of series and parallel magnetic circuits.

UNIT-V: Network theorems (DC Excitations): Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem.

UNIT-VI: Network theorems (AC Excitations): Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,McGraw Hill Company,6 thedition
2. Network Analysis: Van Valkenburg; Prentice-Hall of India PrivateLtd

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, McGraw Hill Education (India)
2. Linear Circuit Analysis by De Carlo, Lin, Oxfordpublications
3. Electric Circuits– (Schaum's outlines) by MahmoodNahvi& Joseph Edminister, Adapted by KumaRao, 5th Edition – McGrawHill.
4. Electric Circuits by David A. Bell, Oxfordpublications
5. Introductory Circuit Analysis by Robert L Boylestad, PearsonPublications
6. Circuit Theory(Analysis and Synthesis) byA.Chakrabarthi,DhanpatRai&Co.

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Course Code 20EE3T2	ELECTRICAL CIRCUIT ANALYSIS-II	L 3	T 1	P --	C 3

PURPOSE: This course aims at study of three phase systems, transient analysis, network synthesis and fourier analysis for the future study and analysis of power systems.

COURSE OBJECTIVES:	
1	To study the concepts of balanced three-phasecircuits.
2	To study the concepts of unbalanced three-phasecircuits.
3	To study the transient behaviour of electrical networks with DC, pulse and AC excitations.
4	To understand the application of fourier series and fourier transforms for analysis of electricalcircuits.
5	To study the performance of a network based on input and outputexcitation/response.
6	To understand the realization of electrical network function into electrical equivalent passiveelements.
COURSE OUTCOMES: Students are able to	
1	Solve three- phase circuits under balanced and unbalanced condition
2	Find the transient response of electrical networks for different types ofexcitations.
3	Find parameters for different types ofnetwork.
4	Realize electrical equivalent network for a given network transfer function.
5	Extract different harmonics components from the response of a electricalnetwork.

UNIT-I-Balanced Three phase circuits: Phase sequence- star and delta connection - relation between line and phase voltages and currents - analysis of balanced three phase circuits - measurement of active and reactive power.

UNIT-II Unbalanced Three phase circuits: Analysis of three phase unbalanced circuits: Loop method – Star-Delta transformation technique, Two wattmeter methods for measurement of three phase power.

UNIT-III Transient Analysis in DC and AC circuits: Transient response of R-L, R-C, R-L-C circuits for DC and AC excitations, Solution using differential equations and Laplace transforms.

UNIT-IV Fourier analysis and Transforms: Fourier theorem- Trigonometric form and exponential form of Fourier series, Conditions of symmetry- line spectra and phase angle spectra, Analysis of electrical circuits to non sinusoidal periodic waveforms. Fourier integrals and Fourier transforms – properties of Fourier transforms, physical significance of the Fourier Transform and its application to electrical circuits.

UNIT-V Two Port Networks: Two port network parameters – Z, Y, ABCD and Hybrid parameters and their relations, Cascaded networks - Poles and zeros of network functions.

UNIT-VI Network synthesis: Positive real function - basic synthesis procedure - LC immittance functions - RC impedance functions and RL admittance function - RL impedance function and RC admittance function - Foster and Cauer methods.

Text Books:

1. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,McGraw Hill Company,6 thedition
2. Network synthesis: Van Valkenburg; Prentice-Hall of India PrivateLtd

Reference Books:

1. Fundamentals of Electrical Circuits by Charles K.Alexander and Mathew N.O.Sadiku, McGraw Hill Education (India)
2. Introduction to circuit analysis and design by TildonGlisson.Jr,Springer Publications.
3. Circuits by A.BruceCarlson ,Cengage LearningPublications
4. Network Theory Analysis and Synthesis by SmarajitGhosh, PHIpublications
5. Networks and Systems by D. Roy Choudhury, New Age Internationalpublishers
6. Electric Circuits by David A. Bell, Oxfordpublications
7. Circuit Theory (Analysis and Synthesis) byA.Chakrabarthi,DhanpatRai&Co.

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Course Code **20EE3T3**	**ELECTRICAL MACHINES -I**	L 3	T 0	P --	C 3

PURPOSE: This is a basic course on rotating electrical machines. This course covers the topics related to principles, performance, applications and design considerations of dc machines and transformers.

	COURSE OBJECTIVES : To Prepare the Students to
1	Understand the construction, principle of operation and performance of DC Generator.
2	Understand the construction, principle of operation and performance of DC Motor.
3	Learn the characteristics, performance, methods of speed control and testing methods of DCmotors.
4	To predetermine the performance of single phase transformers with equivalent circuit models
5	Understand the methods of testing of single-phasetransformer.
6	Analyze the three phase transformers and achieve three phase to two phase conversion.
	COURSE OUTCOMES : Students are able to
1	Assimilate the concepts of construction & working of DC Generator.
2	Mitigate the ill-effects of armature reaction and improve commutation in dc machines.
3	Understand the torque production mechanism and control the speed of dc motors.
4	Analyze the performance of single phasetransformers.
5	Predetermine regulation, losses and efficiency of single phasetransformers.
6	Parallel transformers, control voltages with tap changing methods and achieve three-phase to two-phasetransformation.

UNIT–I: DC Generators: Construction and principle of operation of DC machine – EMF equation for generator – Classification of DC machines based on excitation – OCC of DC shunt generator.Characteristics of dc generators and its applications.

UNIT–II: DC Motors: Torque and back-emf equations of dc motors– Armature reaction and commutation – characteristics of separately-excited, shunt, series and compound motors - losses and efficiency- applications of dc motors -Effects of armature reaction

UNIT-III: Starting, Speed Control and Testing of D.C. Machines: Necessity of starter – Starting by 3 point and 4 point starters – Speed control by armature voltage and field control – testing of DC machines - brake test, Swinburne's method – principle of regenerative or Hopkinson's method - separation of losses.

UNIT–IV: Single-phase Transformers Types and constructional details - principle of operation - emf equation - operation on no load and on load – lagging, leading and unity power factors loads - phasor diagrams of transformers – equivalent circuit – regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency.

UNIT-V: Single-phase TransformersTesting: Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses – parallel operation with equal voltage ratios – auto transformer - equivalent circuit – comparison with two winding transformers.

UNIT-VI: 3-Phase Transformers: Polyphase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ -- Third harmonics in phase voltages three winding transformers: determination of Zp, Zs and Zt -- transients in switching - off load and on load tap changers -- Scottconnection-Comparison of 1-phase and 3-phase transformer and its applications

Text Books:

1. Electrical Machines – P.S. Bhimbra, KhannaPublishers
2. Electric Machinery by A.E.Fitzgerald,Charleskingsley,StephenD.Umans,TMH

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth,McGrawHill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications,5th edition.
3. Electrical Machinery by AbijithChakrabarthi and SudhiptaDebnath,McGraw Hill education2015
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education2010
5. Electric Machines by MulukutlaS.Sarma&Mukeshk.Pathak, CENGAGELearning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria&Sons

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Course Code **20EE3T5**	**POWER SYSTEMS-I**	**L** **3**	**T** **--**	**P** **--**	**C** **3**

PURPOSE: Electrical Power plays significant role in day to day life of entire mankind. The aim of this course is to allow the students to understand the concepts of the generation and distribution of power along with economic aspects.

COURSE OBJECTIVES: To Prepare the Students

1	To study the principle of operation of different components of a thermal power stations.
2	To study the principle of operation of different components of a Nuclear power stations.
3	To study the concepts of DC/AC distribution systems and voltage drop calculations.
4	To study the constructional and operation of different components of an Air and Gas Insulatedsubstations.
5	To study theconstructionaldetails of different typesofcables.
6	To study different types of load curves and tariffs applicable toconsumers.

COURSE OUTCOMES : Students are able to

1	Identify the different components of thermal powerplants.
2	Identify the different components of nuclear Powerplants.
3	Distinguish between AC/DC distribution systems and also estimate voltage drops of distributionsystems.
4	Identifythe different components of air and gas insulated substations.
5	Identifysingle core and multi core cables with different insulatingmaterials.
6	Analyzethe different economic factors of power generation andtariffs.

UNIT-I Thermal Power Stations: Selection of site, general layout of a thermal power plant showing paths of coal, steam, water, air, ash and flue gasses, ash handling system, Brief description of components: Boilers, Super heaters, Economizers, electrostatic precipitators, steam Turbines : Impulse and reaction turbines, Condensers, feed water circuit, Cooling towers and Chimney.

UNIT-II Nuclear Power Stations: Location of nuclear power plant, Working principle, Nuclear fission, Nuclear fuels, Nuclear chain reaction, nuclear reactor Components : Moderators, Control rods, Reflectors and Coolants.Types of Nuclear reactors and brief description of PWR, BWR and FBR.Radiation: Radiation hazards and Shielding, nuclear waste disposal.

UNIT-III Distribution Systems: Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

UNIT-IVSubstations: Classification of substations: Air Insulated Substations - Indoor & Outdoor substations, Substations layouts of 33/11 kV showing the location of all the substation equipment.Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams. Gas Insulated Substations (GIS) – Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, constructional aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

UNIT-V Underground Cables: Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation and power factor of cable. Capacitance of single and 3-Core belted Cables.Grading of Cables-Capacitance grading and Inter sheath grading.

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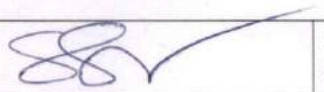
UNIT-VI Economic Aspects of Power Generation & Tariff: Economic Aspects - Load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, Plant capacity factor and plant use factor, Base and peak load plants. Tariff Methods- Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Desirable Characteristics of a Tariff Method, Tariff Methods: Simple rate, Flat Rate, Block-Rate, two-part, three–part, and power factor tariff methods.

Text Books:

1. ATextBookonPowerSystemEngineeringbyM.L.Soni,P.V.Gupta,U.S.Bhatnagarand A. Chakrabarti, DhanpatRai& Co. Pvt. Ltd.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa New age International (P) Limited, Publishers.

Reference Books:

1. Electrical PowerDistributionSystems by -V. Kamaraju, TataMcGraw Hill, New Delhi.
2. Elements of Electrical Power Station Design by – M V Deshpande, PHI, NewDelhi.

Dr S Sivanagaraju, Professor, EEE, JNTUk		Sri L Jagadeesh, Senior Officer, KECIL.	
Dr G Yesuratnam, Professor, EED, OU.		Sri K Satish Kumar, Research Scholor, NIT	
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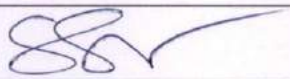
Course Code **20EE3L1**	**ELECTRICAL CIRCUITS LAB**	**L** --	**T** --	**P** **3**	**C** **1.5**

Course objectives: To Prepare the studentsto verify and demonstrate various thermos,locus diagrams, resonance and two portnetworks.To determine self and mutual inductance of a magnetic circuit, parameters of agiven coil and measurement of 3- phase power.

Courseoutcomes: Students are able to apply various thermos, determination of self and mutual inductances, two portparameters of a given electric circuits. Able to draw locus diagrams. Waveforms and phasordiagram for lagging and leading networks.

LIST OF EXPERIMENTS (Conduct Minimum 10 Experiments)

1) Determination of cold and hot resistance of an electriclamp.
2) Find out Parameters of a chokecoil.
3) Determination of Self, Mutual Inductances and Coefficient ofcoupling
4) Series and ParallelResonance
5) Locus Diagrams of RL and RC SeriesCircuits
6) Verification of Thevenin's and Norton'sTheorems
7) Verification of Superposition theorem and Maximum Power TransferTheorem
8) Verification of CompensationTheorem
9) Verification of Reciprocity , Millmann'sTheorems
10) Find out the Z and YParameters of a given two port network.
11) Transmission and hybridparameters
12) Measurement of 3-phase Power by two Wattmeter Method for unbalancedloads

Dr S Sivanagaraju, Professor, EEE, JNTUk		Sri L Jagadeesh, Senior Officer, KECIL.	
Dr G Yesuratnam, Professor, EED, OU.		Sri K Satish Kumar, Research Scholor, NIT	
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Course Code **20EE3L2**	**ELECTRICAL MACHINES-I LAB**	**L** --	**T** --	**P** **3**	**C** **1**

Corse Objectives: To Prepare the Students

- To plot the magnetizing characteristics of DC shunt generator and understand the mechanism of self-excitation.
- To control the speed of the DC motors.
- To Determine and predetermine the performance of DC machines.
- To predetermine the efficiency and regulation of transformers and assess their performance.

Course outcomes:

- To determine and predetermine the performance of DC machines and Transformers.
- To control the speed of DC motor.
- To achieve three phase to two phase transformation.

LIST OF EXPERIMENTS (Conduct Minimum 10 Experiments)

1. Magnetization characteristics of DC shunt generator. Determination of critical field resistance and critical speed.
2. Speed control of DC shunt motor by Field and armatureControl.
3. Brake test on DC shunt motor. Determination of performancecurves.
4. Swinburne's test and Predetermination of efficiencies as Generator andMotor.
5. Separation of losses in DC shuntsmotor.
6. Hopkinson's test on DC shunt machines. Predetermination ofefficiency.
7. OC & SC test on single phasetransformer.
8. Sumpner's test on single phasetransformer.
9. Scott connection oftransformers
10. Parallel operation of Single phaseTransformers
11. Separation of core losses of a single phasetransformer
12. Heat run test on a bank of 3 Nos. of single phase Delta connectedtransformers

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Course Code **20EE3L3**	**ELECTRONIC DEVICES & CIRCUITS LAB**	**L** --	**T** --	**P** 3	**C** 1

PURPOSE: The students are required to perform the experiment to obtain the V-I characteristics and to determine the relevant parameters from the obtained graphs.

Electronic Workshop Practice:

1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Coils, Gang Condensers, Relays, BreadBoards.
2. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR,UJT.
3. Soldering Practice- Simple circuits using active and passivecomponents.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Multimeter, Function Generator, Regulated Power Supply andCRO.

List of Experiments: (MINIMUM 10 EXPERIMENTS TO BE CONDUCTED)

1. P-N Junction DiodeCharacteristics

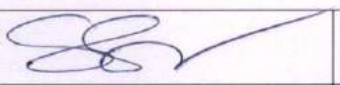
   Part A: Germanium Diode (Forward bias& Reverse bias)
   Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics

   Part A: V-ICharacteristics
   Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)

   Part A: Half-waveRectifier
   Part B: Full-wave Rectifier
4. BJT Characteristics(CE Configuration)

   Part A: Input Characteristics
   Part B: Output Characteristics
5. FET Characteristics(CS Configuration)

   Part A: DrainCharacteristics
   Part B: Transfer Characteristics
6. SCRCharacteristics
7. UJTCharacteristics
8. TransistorBiasing
9. CRO Operation and itsMeasurements
10. BJT-CEAmplifier
11. Emitter Follower-CCAmplifier
12. FET-CSAmplifier

Dr S Sivanagaraju, Professor, EEE, JNTUk		Sri L Jagadeesh, Senior Officer, KECIL.	
Dr G Yesuratnam, Professor, EED, OU.		Sri K Satish Kumar, Research Scholor, NIT	
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Course Code **20SE3T6A**	**ELECTRICAL SAFETY**	**L** **3**	**T** **0**	**P** **--**	**C** **3**

PURPOSE: To study the basic concepts of electrical safety and regulations

COURSE OBJECTIVES : To Prepare the Students to

1	To study the electrical safety rules, regulations and quality management by the power factor improvement.

COURSE OUTCOMES : Students are able to

1	Understand the Indian electricity rules and their significance
2	Explain the safety standard in residential, commercial, and agricultural
3	Learn about electrical safety installation, testing and commission
4	Understand about flashovers and corona discharge
5	Understand about electrical safety in distribution system

UNIT–I: INDIAN ELECTRICITY RULES AND ACTS AND THEIR SIGNIFICANCE:

Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage – earthing of system neutral – Rules regarding first aid and firefighting facility.

UNIT–II: ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS:

Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT-III: SAFETY DURING INSTALLATION, TESTING AND COMMISSIONING, OPERATION AND MAINTENANCE:

Preliminary preparations – safe sequence – risk of plant and equipment – safety documentation – field quality and safety - personal protective equipment – safety clearance notice – safety precautions – safeguards for operators – safety

UNIT–IV: ELECTRICAL SAFETY IN HAZARDOUS AREAS

Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

UNIT-V:ELECTRICAL SAFETY IN DISTRIBUTION SYSTEM

Total quality control and management – Importance of high load factor – Disadvantages of low power factor – Causes of low P.F. – power factor improvement – equipments – Importance of P.F. improvement.

Text Books:

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. PradeepChaturvedi, "Energy Management Policy, Planning and Utilization", Concept Publishing Company, 1997.

Reference Books:

1. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
2. Gupta, B.R., "Power System Analysis and Design", S.Chand and Sons, 2003.
3. Wadhwa, C.L., "Electric Power Systems", New Age International, 2004

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Course Code **20EE4T2**	**CONTROL SYSTEMS**	**L** **3**	**T** **1**	**P** **--**	**C** **3**

PURPOSE: This course introduces the elements of linear control systems and their analysis. Classical methods of design using frequency response. The state space approach for design, modeling and analysis of simple PD,PID controllers.

COURSE OBJECTIVES : To Prepare the Students	
1	To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transferfunction
2	To analyze the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integralcontrollers
3	To investigate the stability of closed loop systems using Routh's stability criterion and the analysis by root locusmethod.
4	To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots, polar plots and Nyquist stabilitycriterion.
5	To discuss basic aspects of design and compensation of linear control systems using Bodeplots.
6	Ability to formulate state models and analyze the systems. To present the concepts of Controllability and Observability.
COURSE OUTCOMES : Students are able to	
1	Derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
2	Determine time response specifications of second order systems and to determine error constants.
3	Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
4	Analyze the stability of LTI systems using frequency response methods.
5	Design Lag, Lead, Lag-Lead compensators to improve system performance from Bode diagrams.
6	Represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

UNIT – I: Mathematical Modeling Of Control Systems: Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Transfer Function of DC Servo motor - AC Servo motor- Synchro, transmitter and receiver - Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

UNIT-II:Time Response Analysis: Standard test signals - Time response of first and second order systems - Time domain specifications - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.

UNIT – III:Stability and Rootlocus Technique: The concept of stability – Routh's stability criterion – limitations of Routh's stability –Root locus concept - construction of root loci.

UNIT–IV: Frequency Response Analysis: Frequency domain specifications-Bode diagrams- transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots, Polar Plots, Nyquist Stability criterion.

UNIT–V:Classical Control Design Techniques: Lag, Lead, Lag-Lead compensators, design of compensators – using Bode plots.

UNIT–VI:State Space Analysis OfLTI Systems: Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Text Books:

1. Control Systems Engineering, I.J.Nagarath and M.Gopal, NewageInternational Publications, 5th Edition.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall ofIndia,2nd Edition.

Reference Books:

1. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India.
2. Control Systems, ManikDhanesh N, Cengage publications.
3. Control Systems principles and design, M.Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition.
4. Control Systems Engineering, S.Palani,TataMcGraw HillPublications.

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Course Code **20EE4T3**	**POWER SYSTEMS-II**	**L** **3**	**T** **1**	**P** **--**	**C** **3**

PURPOSE: This course is an extension of power systems–I course. It deals with basic theory of transmission lines modeling and their performance analysis. Transient in power system, improvement of power factor and voltage control are discussed in detail. It is important for the student to understand the mechanical design aspects of transmission lines, cables, insulators. These aspects are also covered in detail in thiscourse.

COURSE OBJECTIVES : To Prepare the Students

1	To compute inductance/capacitance of transmission lines and to understand the concepts ofGMD/GMR.
2	To study the short and medium length transmission lines, their models and performance.
3	To study the performance and modelling of long transmissionlines.
4	To study the effect of travelling waves on transmissionlines.
5	To study the factors affecting the performance of transmission lines and power factor improvementmethods.
6	To discuss sag and tension computation of transmission lines as well as to study the performance of overheadinsulators.

COURSE OUTCOMES : To Students are able to

1	Understand parameters of various types of transmission lines.
2	Understand the performance of short and medium transmissionlines.
3	Understand travelling waves on transmissionlines.
4	Understand various factors governing the performance of Transmission Lines.
5	Understand sag/tension of transmission lines and performance of line insulators.

UNIT–I:Transmission Line Parameters: Conductor materials - Types of conductors – Calculation of resistance for solid conductors – Calculation of inductance for single phase and three phase– Single and double circuit lines– Concept of GMR and GMD–Symmetrical and asymmetrical conductor configuration with and without transposition–Bundled conductors-Calculation of capacitance for 2 wire and 3 wire systems – Effect of ground on capacitance – Capacitance calculations for symmetrical and asymmetrical single and three phase–Single and double circuit lines- Bundled conductors.

UNIT–II:Performance of Short and Medium Length Transmission Lines: Classification of Transmission Lines and their model representations –Nominal-T–Nominal-Pie and A, B, C, D Parameters for regulation and efficiency of lines.

UNIT–III:Performance of Long Transmission Lines: Long Transmission Line–Rigorous Solution – Evaluation of A,B,C,D Constants– Interpretation of the Long Line Equations, regulation and efficiency– Incident, Reflected and Refracted Waves –Surge Impedance and SIL of Long Lines–Wave Length and Velocity of Propagation of Waves – Representation of Long Lines – Equivalent-T and Equivalent Pie network models.

UNIT – IV:Power System Transients: Types of System Transients – Travelling or Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients – Termination of lines with different types of conditions: Open Circuited Line–Short Circuited Line – T-Junction– Lumped Reactive Junctions.

UNIT–V:Various Factors governing the Performance of Transmission line: Skin and Proximity effects – Description and effect on Resistance of Solid Conductors – Ferranti effect – Charging Current –Shunt Compensation –Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss – Radio Interference.

UNIT–VI:Sag and Tension Calculations and Overhead Line Insulators: Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor– Stringing chart and sag template and its applications–Types of Insulators – String efficiency and Methods for improvement–Calculation of string efficiency–Capacitance grading and Static Shielding.

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Text Books:

1. Electrical power systems – by C.L.Wadhwa, New Age International (P) Limited, Publishers,1998.
2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition

Reference Books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies,4th edition
2. Power System Analysis and Design by B.R.Gupta, WheelerPublishing.
3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.BhatnagarA.Chakrabarthy, DhanpatRai& Co Pvt. Ltd.
4. Electrical Power Systems by P.S.R. Murthy,B.S.Publications.

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Course Code **20EE4T1**	**ELECTRO MAGNETIC FIELDS**	**L** **3**	**T** **1**	**P** **--**	**C** **3**

PURPOSE: Electromagnetic fields are the pre-requisite for most of the subjects in the gamut of electrical engineering. The study of this subject enables students to understand and interpret the phenomenon pertinent to electrical engineering using microscopic quantities such as electric and magnetic field intensities, scalar and vector potentials.

COURSE OBJECTIVES: To Prepare the Students	
1	To study the production of electric field and potentials due to different configurations of staticcharges.
2	To study the properties of conductors and dielectrics, calculate the capacitance of various configurations and understand the concept of conduction and convection currentdensities.
3	To study the magnetic fields produced by currents in different configurations, application of ampere's law and the Maxwell's second and thirdequations.
4	To study the magnetic force and torque through Lorentz force equation in magnetic field environment like conductors and other currentloops.
5	To develop the concept of self and mutual inductances and the energystored.
6	To study time varying and Maxwell's equations in different forms and Maxwell's fourth equation for the inducede.m.f.
COURSE OUTCOMES: Students are able to	
1	Determine electric fields and potentialusing gauss's lawor solving Laplace's or Poisson's equations, for various electric chargedistributions.
2	Calculate and design capacitance, energy stored indielectrics.
3	Calculate the magnetic field intensity due to current, the application of ampere's law and the Maxwell's second and thirdequations.
4	Determine the magnetic forces and torque produced by currents in magneticfield
5	Determine self and mutual inductances and the energy stored in the magneticfield.
6	Calculate induced e.m.f., understand the concepts of displacement current and Poyntingvector.

UNIT – IElectrostatics-I: Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Guass's law –- Maxwell's first law(div(D)=ρ_v) Laplace's and Poison's equations and Solution of Laplace's equation in onevariable.

UNIT – II Electrostatics-II: Electric dipole – Dipole moment – potential and EFI due to an electric dipole – Torque on an Electric dipole in an electric field – Behaviour of conductors in an electric field – Boundary conditions between conductor to Dielectric and dielectric to dielectrics capacitance – capacitance of parallel plates, spherical and coaxial cables with composite dielectrics –Energy stored and energy density in a static electric field – Current density – conduction and Convection current densities – Ohm's law in point form – Equation of continuity

UNIT – III Magneto statics and Ampere's Law: Static magnetic fields – Biot-Savart's law – Magnetic field intensity (MFI) – MFI due to a straight current carrying filament – MFI due to circular, square and solenoid current Carrying wire –Definitions of magnetic flux, magnetic flux density and MFI and their relations – Maxwell's second Equation (div(B)=0) –Ampere's circuital law and its applications viz. MFI due to an infinite sheet of current and a long filament carrying conductor – Point form of Ampere's circuital law –Field due to a circular loop, rectangular and square loops, Maxwell's third equation (Curl(H)=J).

UNIT – IV Force in Magnetic fields: Magnetic force - Moving charges in a Magnetic field – Lorentz force equation – force on a current element in a magnetic field – Force on a straight and a long current carrying conductor in a magnetic field – Force between two straight long and parallel current carrying conductors – Magnetic dipole and dipole moment – a differential current loop as a magnetic dipole – Torque on a current loop placed in a magneticfield-scalar and vector magnetic potential and limitations.

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UNIT – V Self and Mutual inductance: Self and Mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

UNIT – VI Time Varying Fields: Time varying fields – Faraday's laws of electromagnetic induction – Its integral and point form – Maxwell's fourth equation(Curl (E)=-∂B/∂t) – Statically and Dynamically induced EMFs –Modification of Maxwell's equations for time varying fields – Displacement current – Poynting Theorem and Poyntingvector-*Maxwell's equations in one word statement.*

Text Books:

1. "Engineering Electromagnetics" by William H. Hayt& John. A. Buck Mc. Graw-Hill Companies, 7th Editon.2006.

Reference Books:

1. " Principles of Electro Magnetics" by Sadiku, Oxford Publications,4th edition
2. "Introduction to Electro Dynamics" by D J Griffiths, Prentice-Hall of India Pvt.Ltd, 2nd edition
3. "Electromagnetic Field Theory" byYaduvirSingh,Pearson.
4. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan,Oxford higher Education.

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Course Code **20EE4T4**	**ELECTRICAL MACHINES – II**	**L** **3**	**T** **1**	**P** **--**	**C** **3**

PURPOSE: This course covers the topics on 3-phase induction motor, 1-phase induction motorand synchronous machines which have wide application in power systems. The main aim of the course is to provide a detailedanalysis of operation and performance of 3-phase induction motor, 1-phase induction motorand synchronous machines. In addition,it also covers voltage regulation and parallel operation of synchronous generators.

COURSE OBJECTIVES : To Prepare the Students to

1	Understand the principle of operation and performance of 3-phase induction motor.
2	Quantify the performance of induction motor and induction generator in terms of torque andslip.
3	Understand the torque producing mechanism of a single phase induction motor.
4	Understand the principle of emf generation, the effect of armature reaction and predetermination of voltage regulation in synchronous generators.
5	Study parallel operation and control of real and reactive powers for synchronous generators.
6	Understand the operation, performance and starting methods of synchronous motors.

COURSE OUTCOMES : Students are able to

1	Explain the operation and performance of three phase induction motor.
2	Analyze the torque-speed relation, performance of induction motor and induction generator.
3	Explain design procedure for transformers and three phase induction motors.
4	Implement the starting of single phase induction motors.
5	Perform winding design and predetermine the regulation of synchronous generators.
6	Implement methods of staring and correction of power factor with synchronous motor.

UNIT-I: 3- phase InductionMotors: Construction details of cage and wound rotor machines - production of rotating magnetic field - principle of operation - rotor emf and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram

UNIT-II: Characteristics, starting and testing methods of Induction Motors: Torque equation - expressions for maximum torque and starting torque - torque slip characteristic - double cage and deep bar rotors - crawling and cogging – speed control of induction motor with V/f method – no load and blocked rotor tests - circle diagram for predetermination of performance– methods of starting – starting current and torque calculations – induction generator operation (Qualitative treatment only)

UNIT – III:Single phase induction motor: Single Phase Motors: Single phase induction motors – Constructional features and equivalent circuit Problem of starting–Double revolving field theory– Starting methods, shaded pole motors, AC Series motor.

UNIT–IV:Construction, Operation and Voltage Regulation of Synchronous generator: Constructional features of non–salient and salient pole type – Armature windings – Distributed and concentrated windings – Distribution– Pitch and winding factors –E.M.F equation–Improvements of waveform and armature reaction–Voltage regulation by synchronous impedance method– MMFmethod and Potier triangle method–Phasor diagrams– Two reaction analysis of salient pole machines and phasordiagram.

UNIT –V:Parallel operation of synchronous generators: Parallel operation with infinite bus and other alternators – Synchronizing power – Load sharing – Control of real and reactive power– Numerical problems.

UNIT–VI:Synchronous motor – operation, starting and performance: Synchronous Motor principle and theory of operation– Phasor diagram – Starting torque– Variation of current and power factor with excitation –Synchronous condenser – Mathematical analysis for power developed– Hunting and its suppression – Methods of starting – Applications.

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Text Books:

1. Electrical Machines – P.S. Bhimbra, KhannaPublishers
2. Electric Machinery by A.E.Fitzgerald,Charleskingsley,StephenD.Umans,TMH

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth,McGrawHill Publications, 4th edition
2. Electrical Machines by R.K.Rajput, Lakshmi publications,5th edition
3. Electrical Machinery by AbijithChakrabarthi and SudhiptaDebnath,McGraw Hill education2015
4. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010
5. Electric Machines by MulukutlaS.Sarma&Mukeshk.Pathak, CENGAGELearning.
6. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons

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Course Code	ELECTRICAL MACHINES-II LAB	L	T	P	C
20EE4L2	Maximum expected contact hours : **36**	--	--	3	2
	Prerequisites : **Knowledge in Mathematics**				

PURPOSE: To control the speed of three phase inductionmotors.To determine /predetermine the performance three phase and single phase induction motors.To improve the power factor of single phase induction motor.To predetermine the regulation of three-phase alternator by various methods, find X_d/ $X_q$ratio of alternator and asses the performance of three-phase synchronousmotor.

LIST OF EXPERIMENTS

Conduct any 10 from the following experiments

1. Brake test on three phase Induction Motor
2. No-load & Blocked rotor tests on three phase Inductionmotor
3. Regulation of a three -phase alternator by synchronous impedance &m.m.f. Methods
4. Regulation of three-phase alternator by Potier trianglemethod
5. V and Inverted V curves of a three—phase synchronousmotor.
6. Determination of X_d and X_q of a salient pole synchronousmachine
7. Equivalent circuit of single phase inductionmotor
8. Speed control of induction motor by V/fmethod.
9. Determination of efficiency of three phase alternator by loading with three phase inductionmotor.
10. Power factor improvement of single phase induction motor by using capacitors and load test on single phase inductionmotor.

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Course Code	CONTROL SYSTEMS& SIMULATION LAB	L	T	P	C
20EE4L3	Maximum expected contact hours : **36**	--	--	3	2
	Prerequisites : **Knowledge in Mathematics**				

PURPOSE: To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors, stepper motor andpotentiometer. To understand time and frequency responses of control system with and without controllers andcompensators.

LIST OF EXPERIMENTS

PART-A

Conduct any 8 from the following experiments

1. Time response of Second ordersystem
2. Characteristics ofSynchros
3. Programmable logic controller – characteristics of steppermotor
4. Effect of feedback on DC servo motor
5. Effect of P, PD, PI, PID Controller on a second ordersystems
6. Lag and lead compensation – Magnitude and phase plot
7. DC position controlsystem
8. Transfer function of DCmotor
9. Temperature controller usingPID
10. Characteristics of magneticamplifiers
11. Characteristics of AC servomotor
12. Characteristics of DC servomotor
13. Potentiometer as an errordetector

PART-B

Conduct any 2 from the following experiments

1. Simulation of transient response of RLCcircuits
    1. Response to pulseinput
    2. Response to stepinput
    3. Response to sinusoidalinput
2. Plotting of Bode plots, root locus and nyquist plots for the transfer functions of systems up to 5^{th} order
3. Simulation of D.C separately excited motor using transfer functionapproach.

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