Bachelor of Technology

Electrical and Electronics Engineering

EEE-Curriculum and syllabus

Rajiv Gandhi University of Knowledge Technologies-Basar

Rajiv Gandhi University of Knowledge and Technology

Basar, Mudhole, Adilabad – 504107

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

I YEAR
I SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE1101	Network Theory-I	4-1-0	4
2	PH1001	Engineering Physics	4-0-0	4
3	MA1101	Mathematics-I	4-0-0	4
4	CS1101	Programming In C	4-0-0	3
5	CE1001	Engineering drawing	4-0-0	4
6	HS1101	Communication Skills – 1	2-0-0	1
7	PH1601	Engineering Physics Lab	0-0-3	2
8	CS1701	Programming In C Lab	0-0-3	2
9	ME1601	Engineering Workshop	0-0-3	2
Total Credits				**26**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE1101 **NETWORK THEORY-I**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-4**

Course Objectives:

- 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 Circuit concepts, magnetic circuits

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

- Evaluate steady state behavior of single port networks for DC and AC excitations.
- Analyze and solve magnetic circuits and 3-phase circuits

UNIT- I:

R-L-C Parameters, Voltage and Current Independent and Dependent Sources, Voltage - Current Relationship for Passive Elements (For Different Input Signals-Square, Ramp, Saw Tooth, Triangular), Kirchhoff's Laws

UNIT- II:

Network reduction techniques – series, parallel, series parallel, star–to-delta, delta-to-star transformation, Source Transformation-Mesh Analysis and Nodal Analysis

UNIT- III:

Single Phase AC Circuits - R.M.S. and Average values, Form Factor, steady state analysis of series, Parallel and Series parallel Combinations of R, L and C with Sinusoidal excitation, concept of reactance, Impedance, Susceptance and Admittance – phase and phase difference, Concept of Power Factor, j-notation, complex and Polar forms of representation.

UNIT-IV:

Single phase Series, Parallel, Series –Parallel circuits, Solution of AC networks using mesh and nodal analysis,

Resonance – Series resonance and Parallel resonance circuits, concept of bandwidth and Q factor, Locus Diagrams for RL, RC and RLC Combinations for Various Parameters.

UNIT-V:

Magnetic Circuits: Faraday's Laws of Electromagnetic Induction-Concept of Self and Mutual
Inductance-Dot Convention-Coefficient of Coupling-Composite Magnetic Circuit-Analysis of Series and Parallel Magnetic Circuits, MMF Calculations

Three Phase Circuits: Phase Sequence- Star and Delta Connection-Relation Between Line and Phase Voltages and Currents in Balanced Systems-Analysis of Balanced Three Phase Circuits- Measurement of Active and Reactive Power in Balanced and Unbalanced Three Phase Systems– Two Wattmeter Method of Measurement of Three Phase Power.

Text Books:

1. Edward Hughes, "Electrical Technology", 10th Edition, ELBS, 2010.
2. M.E Van Valkenburg "Network Analysis", Prentice Hall (India), 3rd Edition, 2012.
3. Chakrabarti "Circuit Theory (Analysis & Synthesis) ", Dhanpat Rai & Sons, 2010.

Reference Books:

1. Sudhakar and Shyammohan S Palli ,"Circuits & Networks", Tata McGraw- Hill, 2010.
2. N.Sreenivasulu, " Electric Circuits", REEM Publications, 2013.
3. William Hayt and Jack E. Kemmerly, " Engineering circuit analysis", Mc Graw Hill Company, 6^{th} edition, 2005.
4. John Bird, Routledge, "Electrical Circuit Theory and Technology", Taylor & Fransis, 2007.

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

I YEAR

II SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE1201	Network Theory-II	4-1-0	4
2	CY1001	Chemistry	4-0-0	4
3	MA1201	Mathematics-II	4-0-0	4
4	CS1201	Scripting Languages	4-0-0	3
5	HS1001	English	4-0-0	4
6	HS1201	Communication Skills-II	2-0-0	1
7	EE1801	Network Theory Lab	0-0-3	2
8	CY1601	Chemistry Lab	0-0-3	2
9	HS1601	English Lab	0-0-3	2
Total Credits				**26**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE1201 **NETWORK THEORY-II**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-4**

Course Objectives:

- 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 network theorems, transient analysis and network topology etc.

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

- Evaluate transient behavior of single port networks for DC and AC excitations.
- Examine behavior of linear circuits using Laplace transform and transfer functions of single port and two port networks
- Analyze electric circuits using Network Theorems and network topology (Graph theory)

UNIT- I:

Network Theorems - The venin's, Norton's, Maximum Power Transfer, Superposition, Reciprocity, Tellegen's, Millman's and Compensation theorems for DC and AC excitations.

UNIT- II:

D.C Transient Analysis: Transient Response of R-L, R-C, R-L-C Series Circuits for D.C Excitation- Initial Conditions-Solution Method Using Differential Equation and Laplace Transforms, Response of RL & R-C Networks to Pulse Excitation.

UNIT-III:

A.C Transient Analysis: Transient Response of R-L, R-C, R-L-C Series Circuits for Sinusoidal
Excitations-Initial Conditions-Solution Method Using Differential Equations and Laplace Transforms

UNIT- IV:

Transfer functions: poles and zeros; Elements of Filter Theory

Synthesis of Single –Port Networks

Positive real functions Hurwitz polynomials, Realization of passive LC –RL and RC networks using Foster and Caner forms.

UNIT- V:

Two port networks:

Driving point impedance and transfer functions of 1-port RLC – networks, Impedance, admittance, Transmission and hybrid parameters of two-port networks and their interrelationship

Network Topology: Definitions – Graph – Tree, Basic Cutset and Basic Tieset Matrices for Planar Networks – Loop and Nodal Methods of Analysis of Networks with Dependent & Independent Voltage and Current Sources – Duality & Dual Networks.

Text Books:

1. M.E Van Valkenburg "Network Analysis", Prentice Hall (India), 3rd Edition, 2012.
2. Chakrabarti "Circuit Theory (Analysis & Synthesis) ", Dhanpat Rai & Sons, 2010.

Reference Books:

1. Sudhakar and Shyammohan S Palli ,"Circuits & Networks", Tata McGraw- Hill, 2010.
2. N.Sreenivasulu, " Electric Circuits", REEM Publications, 2013.
3. William Hayt and Jack E. Kemmerly, " Engineering circuit analysis", Mc Graw Hill Company, 6th edition, 2005.
4. John Bird, Routledge, "Electrical Circuit Theory and Technology", Taylor & Fransis, 2007.

EE1801 **NETWORK THEORY LAB**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objective:

- To expose the students to the concepts of electrical and electronics circuits and give them experimental skills.

Course Outcomes: Upon completion of this course

- The student will be able to perform experiments to verify network theorems
- The student will be able to perform experiments to study transient and steady state behavior of electrical circuits for DC and Sinusoidal excitation
- The student will be able to perform experiments to determine the two port network parameters

List of Experiments:

1. Verification of Ohm's Law, KCL and KVL
2. Verification of Thevenin's Theorem
3. Verification of Maximum Power Transfer Theorems
4. Verification of Superposition theorem and Reciprocity Theorem
5. Transient and frequency response of RLC series circuit
6. Series and Parallel Resonance
7. Z and Y Parameters
8. Transmission and hybrid parameters
9. Study of transfer characteristic of circuits containing diodes to find cut-in voltage.

Any two of the following simulation experiments

1. Simulation of DC Circuits
2. DC Transient response
3. Mesh Analysis
4. Nodal Analysis

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

II YEAR
I SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE2101	Electrical Machines-I	4-1-0	4
2	EC2101	Electronic Circuits	4-0-0	4
3	EC2104	Electro Magnetic Field Theory	4-0-0	4
4	ME2105	Fluid Mechanics and Hydraulic Machines	4-0-0	4
5	MA2105	Mathematics-III	4-0-0	4
6	HS2101	Soft Skills-I	2-0-0	1
7	EE2701	Electrical Machines-I Lab	0-0-3	2
8	EC2701	Electronic Circuits Lab	0-0-3	2
9	EE2901	Seminar – 1	0-0-3	1
Total Credits				**26**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE2101 ELECTRICAL MACHINES – I

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-4**

Course Objectives:

This course introduces the concept of

- Construction operational features of energy conversion devices i.e., DC machines and transformers.
- Characteristics of DC machines and transformers and their applications

Course Outcomes:

Upon completion of this course student will be able to

- Analyze the effect of armature reaction and the process of commutation
- Analyze parallel operation of DC Generators, single phase transformers
- Evaluate performance of DC machines and transformers

Unit – I

Principles of Electro-mechanical Energy Conversion- Introduction, Flow of Energy in Electromechanical Devices, Energy in magnetic systems (defining energy & Co-energy), singly excited systems; Determination of mechanical force, Mechanical energy, Torque equation,

Doubly excited Systems; Energy stored in magnetic field, Electromagnetic torque , Generated emf in machines; Torque in machines with cylindrical air gap.

Unit – II

D.C. machine I- Constructional details, Emf and torque equations, circuit model of DC machine,method of excitation, mmf and flux density waveforms, armature reaction and method of limitation of effects of armature reaction(Interpoles and compensating windings,), Commutation process, Improvement of commutation: Brush shift and interpoles. Performance characteristics of D.C. generators and its applications.

Unit –III

D.C. Machines II- Performance characteristics of D.C. motors, Starting of D.C. motors; 3 point and 4 point starters, Speed control of D.C. motors; Field control, Armature control and Voltage control (Ward Lenonard method); Efficiency and Testing of D.C. machines (Hopkinson's and Swinburn's Test) and its applications.

Unit – IV

Single Phase Transformer-

transformer construction, Cooling methods of transformers, principle of operation, equivalent circuit, phasor diagrams, Testing of Transformers- O.C. and S.C. tests, Sumpner's test, Polarity test. Voltage regulation, Efficiency, All day efficiency. separation of hysteresis and eddy current losses.

Unit-V

Auto Transformer- Single phase and three phase auto transformers, Volt-amp relation, Efficiency, Merits & demerits and applications.

Text Books:

1. D.P.Kothari & I.J.Nagrath, "Electric Machines", Tata Mc Graw Hill
2. P.S.Bimbhra, "Electrical Machinery", Khanna Publisher
3. .Ashfaq Hussain "Electric Machines", Dhanpat Rai & Company

Reference Books:

1. P.S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers
2. M.G.Say, "Alternating Current Machines", Pitman & Sons
3. Fitzerald,A.E.,Kingsley and S.D.Umans "Electric Machinery", MC Graw Hill.
4. J.B.Gupta: Theory and Performance of Electrical Machines, S. K. Kataria & Sons, Fourteenth Edn, 2006.

EC2101 ELECTRONIC CIRCUITS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

- To introduce the fundamental concepts of semiconductor devices.
- To understand the operation of different types of electronic devices and their corresponding applications.
- To provide a conceptual foundation on amplifiers that can be used as a basis for further study.

Course Outcomes: Upon completion of the course, students will be able to

- Analyze the operating principles of major electronic devices, its characteristics and applications.
- Design and analyze the DC bias circuitry of BJT and FET.
- Design and analyze basic transistor amplifier circuits using BJT and FET.

UNIT-I:

Introduction to Electronics and Electronic systems, Theory of Semiconductors, pn Junction Diode, Rectifiers: Half Wave Rectifier, Full Wave Rectifier, LEDs, Photo Diodes, Silicon Controlled Rectifier.

UNIT-2:

Bipolar Junction Transistor, Transistor in CB and CE Configurations, Junction Field Effect Transistor, JFET Characteristics, MOSFET, Biasing of Transistors, Biasing of JFET.

UNIT-3:

Introduction to Amplifiers, Transistor Re Model, Transistor h parameter model, BJT Small Signal Analysis, JFET Signal Analysis, feedback Amplifiers, Phase Shift Oscillators, Wein Bridge Oscillators

UNIT-4:

Differential Amplifiers, operational amplifiers, applications of operational amplifiers:, Constant-Gain Multiplier , Voltage Summing , Voltage Buffer , Controller Sources, Instrumentation Circuits ,Active Filters .

UNIT-5:

Logic gates, realization of logic gates, flip-flops, registers and counters.

TEXT BOOKS:

1. Robert L.Boylestad, Louis Nashelsky ,"Electronic Devices and Circuit Theory", 9th edition, PEI,2008
2. David A. Bell ," Electronic Devices and Circuits"- 5th Edition, Oxford University Press.

REFERENCE BOOKS:

1. Donald A Neamen ,"Electronic Circuits Analysis and Design", Third Edition, Tata McGraw-Hill, 2007.
2. Robert T. Paynter, " Introductory Electronic Devices and Circuits", 7th edition, PEI, 2009.
3. Sedra/ Smith, "Microelectric circuits", 5th edition, Oxford University Press, 2009

EC2104 ELECTRO MAGNETIC FIELD THEORY

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

- To find electric and magnetic fields for symmetrical charge and current configurations.
- To deduce EM wave propagation in free space and in dielectric medium
- To analyze electromagnetic wave propagation in guiding structures under various matching conditions
- To understand the power flow mechanism in the losssy and lossless transmission lines.

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

- Find electrical and magnetic fields and can also deduce and analyze EM wave propagation in different media under various matching conditions.
- Analyze the power flow mechanism in the losssy and lossless transmission lines.

UNIT II: Electrostatics

Coulomb's Law, Electric Field Intensity due to different Charge Distributions, Electric Flux Density, Gauss Law and Applications, Electric Potential due to different Charge Distributions, Relations Between E and V, Equipotential Surfaces,Energy Density in the Electrostatic Field.

UNIT III: Conductor, Dielectric and Boundary conditions

Convection and Conduction Currents, current density, continuity Equation, conductor, Dielectric materials and their properties. Boundary conditions between conductor-dielectrics, dielectric-dielectric and conductor-free space. Poisson's and Laplace's equations, General procedure for solving Poisson's and Laplace's equation.

UNIT IV: Magneto statics

Biot-Savart's Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Magnetisation in material,Magnetic torque and moments, Inductances and Magnetic Energy,

Maxwell's Equations (Time Varying Fields): Faraday's Law, General Field Relation for Time Varying Electric And Magnetic Field, Maxwell's Equations in Different Forms, Conditions at a Boundary Surface : Dielectric-Dielectric and Dielectric-Conductor Interfaces. Poynting Vector and Poynting Theorem.

UNIT V:

Electromagnetic waves

Wave Equations for Conducting Media, Uniform Plane Waves – Definition, Relations Between E & H, plane wave in good conductor, skin effect, skin depth.

Transmission Lines:

Types, Parameters, Transmission Line Equations, Expressions for Characteristic Impedance, Input Impedance Relations, SC and OC Lines, Reflection Coefficient, UHF Lines as Circuit Elements : λ/4, λ/2, λ/8 Lines – Impedance Transformations, Single Stub Matching.

Text Books:

1. Matthew N.O. Sadiku , "Elements of Electromagnetics" 4 ed., Oxford Univ.Press ,2008,.
2. William H. Hayt Jr. and John A. Buck , "Engineering Electromagnetics", 7 ed., TMH ,2006.
3. Umesh Sinha, Satya Prakashan , "Transmission Lines and Networks", (Tech. India Publications), New Delhi, , 2001.

Reference Books:

1. E.C. Jordan and K.G. Balmain , "Electromagnetic Waves and Radiating Systems", 2 ed., PHI, 2000.
2. Nathan Ida, " Engineering Electromagnetics", 2 ed., Springer (India) Pvt. Ltd., New Delhi,2005.

EE2701 ELECTRICAL MACHINES-I LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objective:

- To expose the students to the operation of DC machines, transformers and give them experimental skills.

Course Outcomes: Upon completion of the course the student will be able to

- Analyze the characteristics of DC machines and transformers
- Perform tests on DC Machines and transformer and evaluate their performance

Any ten of the following experiments

1. To obtain magnetization characteristics of a d.c. shunt generator.
2. To obtain load characteristics of a d.c. shunt generator and compound generator
3. To obtain efficiency of a dc shunt machine using Swinburn's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine.
5. To obtain speed-torque characteristics of a dc shunt motor.
6. To obtain speed control of dc shunt motor using
   (a) armature resistance control
   (b) field control
7. Polarity and ratio test of single phase transformers.
8. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
9. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
10. Load test on dc series generator
11. Field's test

EC2701 ELECTRONIC CIRCUITS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objectives:

- Familiarizing the students with basic electronics components, devices like multimeter, oscilloscope and signal generator.
- To expose the students to rectifiers, CE amplifiers, OP-AMP and logic gates.

Course Outcomes:

- The student will be able to use basic electronics components and devices like multimeter, oscilloscope and signal generator.
- The student will be able to perform experiments on rectifiers, CE amplifiers, OP-AMP.
- The student will be able to perform experiments on logic gates, 555 circuits and J-K flip-flop.

LIST OF EXPERIMENTS:

1. Familiarization with electronic components and usage of multimeter (measurement of resistance, classification of capacitors, diode testing)
2. Familiarization with Oscilloscope, signal generator and further usage of multimeters
3. Frequency response and square wave resting of R-C, C-R and R-L networks
4. Half-wave and full-wave rectifiers, rectification with capacitive filters, zener diode and IC regulation
5. Studies on CE amplifiers
6. Studies on Analog Circuits using OP-AMP
7. Studies on logic gates
8. Studies on 555 circuits, J-K flip-flop, counters and shift registers

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

II YEAR
II SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE2201	Electrical Machines-II	4-1-0	4
2	EE2202	Linear Control Systems Engineering	4-1-0	4
3	EE2203	Power Systems-I	4-0-0	4
4	EC2205	Signals and Systems	4-0-0	4
5	EC2206	Linear and Digital Electronic Circuits	4-0-0	4
6	BM2201	Personality Development-I	2-0-0	1
7	EE2801	Electrical Machines-II Lab	0-0-3	2
8	EC2806	Linear and Digital Electronic Circuits Lab	0-0-3	2
9	EE2902	Seminar – II	0-0-3	1
Total Credits				**26**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE2201 ELECTRICAL MACHINES – II

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-4**

Course Objectives:

- To understand the construction and principle of operation of three pahse and single phase induction machine and three phase synchronous machine.
- To understand the construction and principle of operation of Special electromechanical Devices.

Course Outcomes: Upon completion of the course student will be able to

- Evaluate performance characteristics of three phase transformer and induction machine
- Analyze speed torque characteristics and control the speed of induction motors .
- Analyze the effects of excitation and harmonics in operation of transformer.

UNIT – I Three Phase Transformers: Construction of Three phase transformer, Phasor groups and their connections, parallel operation of three phase transformers and load sharing, Excitation phenomenon and harmonics in transformers. Tap Changing Transformers: Concept of tap changing, on-load and off-load tap changers.

UNIT -II Multi Winding Transformers: Construction, Equivalent circuits, Determination of equivalent circuit parameters, Voltageregulation, Efficiency calculations. Scott connection of transformers for phase conversion, Open delta connection.

UNIT – III Three phase Induction Machine – I : Constructional details, production of magnetic field-principle of operation, Phasor diagram, equivalent circuit. Torque and output power equations.Torque-slip & power slip characteristics.Testing-no load and blocked rotor tests-determination of equivalent circuit parameters, efficiency. Pre-determination of performance from equivalent circuits and circle diagram.

UNIT – IV Three phase Induction Machine- II : Methods of starting-auto transformer, star delta and rotor resistance starters, Double cage rotor and deep bar rotor induction motor – construction, theory, equivalent circuit, Characteristics and applications. Cogging & Crawling, Speed control (with and without emf injection in rotor circuit). Induction generator & its applications.

UNIT – V Single phase Induction Motor - Double revolving field theory, Equivalent circuit, No load and blocked rotor tests, Starting methods.

Text Books:

1. D.P.Kothari & I.J.Nagrath, “Electric Machines”, Tata Mc Graw Hill
2. P.S.Bimbhra, “Electrical Machinery”, Khanna Publisher
3. Ashfaq Hussain “Electric Machines”, Dhanpat Rai & Company

Reference Books:

1. P.S. Bimbhra, “Generalized Theory of Electrical Machines”, Khanna Publishers
2. M.G.Say, “Alternating Current Machines”, Pitman & Sons

3. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery –Sixth Edition
   TMH 2003.
4. Stephen.J.Chapman: Electric Machinery –Mc Graw Hill International Edition, 2005.
5. J.B.Gupta: Theory and Performance of Electrical Machines, S. K. Kataria & Sons, Fourteenth Edn, 2006.

EE2202 LINEAR CONTROL SYSTEMS ENGINEERING

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-1-0-4**

Course Objectives:

- To introduce the principles and applications of control systems in everyday life.
- The emphasis of this course is laid on stability analysis and design aspects of control systems using classical control theory approaches

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

- Determine the transfer function model and state variable models of electrical, mechanical systems
- Determine the stability of the LTI systems using time domain and frequency domain approaches like root locus, bode plot, Nyquist plot.
- Determine controllability and observability of an LTI system described by a state variable model

UNIT – I:

Concepts of Control Systems- Open Loop and closed loop control systems and their differences- Examples of control systems- Classification of control systems, Feed-Back Characteristics, Effects ofFeedback, Mathematical modeling of physical systems: Differential equation and Transfer functions , Examples of modeling different types (e.g. electrical, mechanical, chemical, biological, social etc.) of systems, Equivalence between the elements of different types of systems. Block diagram algebra –Signal flow graph -Reduction using Mason‘s gain formula.

UNIT -II :

Time Domain Analysis: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications, Steady state response - Steady state errors and error constants, Frequency domain response -- Transfer function and its interpretation in terms of frequency responses peak and peaking frequency, bandwidth and cut-off rate; Advantages of closed loop operation: Sensitivity and complementary sensitivity, Disturbance and noise reduction. Effects of proportional, integral, derivative Controls.

UNIT – III:

The concept of stability – Routh‘s stability criterion – qualitative stability and conditional stability – limitations of Routh‘s stability. The root locus concept - construction of root loci-and relative stability using root-locus approach ,effects of adding poles and zeros to G(s)H(s) on the root loci.

UNIT – IV:

Polar Plots-Nyquist Plots-Stability Analysis. Bode diagrams- Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots. P, PD, PI, PID Controllers and Compensation techniques – Lag, Lead, Lead-Lag Controllers design in frequency Domain,

UNIT – V:

State Variable Analysis of Continuous Systems: Concepts of state, State variables and state model, Derivation of state model from transfer function, Diagonolization, Derivation of transfer function from state model, Solution of state equations, State transition matrix, Concept of Controllability and Observability. **Compensation:** Elementary treatment of Compensation.

TEXTBOOKS:

1. B. C. Kuo and Farid Golnaraghi , "Automatic Control Systems", John wiley and son's, 8th edition, 2003.
2. I. J. Nagrath and M. Gopal , "Control Systems Engineering ", New Age International (P) Limited, Publishers, 5th edition, 2007.
3. Gopal , "Control Systems: Principles and Design", Tata McGraw Hill Pvt.Ltd, 4th Edition, 2012

REFERENCE BOOKS:

1. Katsuhiko Ogata , "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., 5th edition, 2010.
2. NISE , "Control Systems Engineering", 5th Edition – John wiley.

EE2203 POWER SYSTEMS-I

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-4**

Course Objectives:

- Understand the operation of conventional generating stations and renewable sources of electrical power.

- Evaluate the power tariff methods
- Determine the electrical circuit parameters of transmission lines
- Understand the layout of substation and underground cables and corona

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

- Describe the operation of conventional generating stations
- Describe about the different types of substations available
- Determine Different Types of Tariff's in power system
- Design Distribution of voltage along the string insulators & Solve Problems
- Discuss underground cables & Solve Problems

UNIT- I:

Introduction: Typical Layout of an Electrical Power System–Present Power Scenario in India.

Generation of Electric Power:

Conventional Sources (Qualitative): Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant.

Non Conventional Sources (Qualitative): Ocean Energy, Tidal Energy, Wave Energy, wind Energy, Fuel Cells, and Solar Energy, Cogeneration and energy conservation and storage.

UNIT-II:
Substations:
Air insulated substations - Indoor & Outdoor substations: Substations layout 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, 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, bus bar, construction aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

UNIT- III:

Overhead Line Insulators: Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators.

Insulated Cables: Introduction, insulation, insulating materials, Extra high voltage cables, grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cables, Overhead lines versus underground cables, types of cables.

UNIT- IV:

Corona: Introduction, disruptive critical voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and Communication lines.

Mechanical design of transmission lines: The Catenary curve, Sag Tension calculations, Stringing chart, Sag template, Equivalent span, Stringing of conductors, Vibration and Vibration dampers

UNIT- V:

Economics of Generation: Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants. Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.

A.C. Distribution: Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site for substation .

TEXT BOOKS:

1. W.D.Stevenson –"Elements of Power System Analysis", Fourth Edition, McGraw Hill, 1984.
2. C.L. Wadhwa –"Generation, Distribution and Utilization of Electrical Energy", Second Edition, New Age International, 2009
3. C.L. Wadhwa –"Electrical Power Systems", Fifth Edition, New Age International, 2009

REFERENCE BOOKS:

1. M.V. Deshpande –"Elements of Electrical Power Station Design", Third Edition, Wheeler Pub. 1998
2. H.Cotton & H. Barber-"The Transmission and Distribution of Electrical Energy", Third Edition, ELBS, B.I.Pub., 1985
3. Syed A Nasar, "Electric Power Systems" ,Mcgraw-Hill, 1/e, 2006.

EC2205 SIGNALS AND SYSTEMS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

- To explain signals and systems representations/classifications and also describe the time and frequency domain analysis of continuous time signals with Fourier series, Fourier transforms and Laplace transforms.
- To teach Sampling theorem, describe the time and frequency domain analysis of discrete time signals with DTFS, DTFT and Z-Transform.

- To present the concepts of convolution and correlation integrals and also understand the properties in the context of signals/systems.

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

- Describe signals and systems, their classifications and frequency domain representation and properties of signals and sysytems.
- Compute DFT and FFT.
- Design IIR digital filters.

UNIT – I: Classification and characterization of continuous-time and discrete-time signals, common signals, random signals , systems, and applications.

UNIT – II: Signal parameters, impulse response, LTI properties of continuous-time and discrete-time systems, classification of LTI discrete-time systems based on impulse response length, the representation of signal in terms of impulses, linear convolution, Sampling of continuous time signal.

UNIT – III: Fourier series, continuous-time Fourier Transform (CTFT) and Laplace transforms; discrete-time Fourier transforms (DTFT) and Z- transforms.

UNIT – IV: The discrete Fourier Transform (DFT), computation of DFT and operations on finite length sequences, circular convolution and Cooley-Tukey FFT algorithms.

UNIT – V: Analog lowpass filter design, specifications and Butterworth and Chebyshev approximations; Digital filter specifications and Bilinear Transformation method of IIR filter design.

TEXT BOOKS:

1. B.P. Lathi, " Signals, Systems & Communications" , BS Publications, 2009.
2. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, "Signals and Systems", PHI, 2nd Edn.
3. Digital signal processing , A computer base approach- Sanjit K Mitra, Tata Mcgraw Hill, 3rd edition, 2009.
4. John G. Proakis, Dimitris G. Manolakis "Digital signal processing, principles, Algorithms and applications", Pearson Education/PHI, 4th ed., 2007.

REFERENCES:

1. Digital signal processing: Andreas Antoniou, TATA McGraw Hill, 2006.
2. A Text book on Digital Signal processing – R S Kaler, M Kulkarni, Umesh Gupta, I K International Publishing House Pvt. Ltd.

EC2206 LINEAR AND DIGITAL ELECTRONIC CIRCUITS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

- To understand the concepts of various combinational and sequential circuits.
- To learn various techniques for logic circuit reduction.

- To understand the basic building blocks of linear integrated circuits and design op-amp circuits to perform arithmetic operations.
- To know the linear and non-linear applications of operational amplifiers.

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

- Understand the concepts of various combinational and sequential circuits and various techniques for logic circuit reduction.
- Understand the basic building blocks of linear integrated circuits and design op-amp circuits to perform arithmetic operations.
- Analyze the linear and non-linear applications of operational amplifiers

UNIT-I: Digital & analog signals, Number System, BCD & its arithmetic, Binary, Decimal, Hexadecimal, Negative numbers& its arithmetic, Number base conversions, Octal, Duality Principals & Canonical Form, K-Maps, All Logic Gates & Implementations.

UNIT-II: Adders, Array Multiplier Code Converters, Comparators, Decoders (De Multiplexers), Encoders, Multiplexers, Parity Generators Checkers, Sub tractors.

UNIT-III: Adders, Array Multiplier Code Converters, Comparators, Decoders (De Multiplexers), Encoders, Multiplexers, Parity Generators Checkers, Sub tractors, Asynchronous Circuits, Synchronous Circuits, Flip-Flops, Master Slave Operation Flip-Flop, Counters.

UNIT-IV: Basics of Operational Amplifiers : Introduction to op-amps, ideal Characteristics, Pin configuration of 741 op-amps. Bias, offsets and drift, bandwidth and slew rate. DC and AC performance characteristics, Offset and Frequency compensation. Open and closed loop configurations.

Applications Of Operational Amplifiers: Voltage Follower, V-to-I and I-to-V converters, Phase shift Circuits, adder, sub tractor. Instrumentation amplifier, integrator, Differentiator. Logarithmic amplifier, Antilogarithmic amplifier, Precision rectifier, peak detector, clipper and clamper, Sample and Hold Circuits.

UNIT-V: Active Filters: Circuit diagram, frequency response and characteristics of First and second order Low pass, High pass, Band pass Band stop and All pass active filters.

TEXTBOOKS:

1. Switching & Finite Automata theory – Zvi Kohavi, TMH,2nd Edition.
2. Digital Design – Morris Mano, PHI, 3rd Edition, 2006.
3. Switching Theory and Logic Design-A.Anand kumar, 2008.
4. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, 4th Edition, Prentice Hall / Pearson Education, 2001

5. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd.,2000.

REFERENCES:

1. An Engineering Approach to Digital Design – Fletcher, PHI.
2. Fundamentals of Logic Design – Charles H. Roth, 5th Edition, 2004, Thomson Publications.
3. Digital Logic Applications and Design – John M. Yarbrough, 2006.
4. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2007.
5. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.

EE2801 ELECTRICAL MACHINES – II LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objective:

- To expose the students to the operation and performance of synchronous machines and Induction motors and give them experimental skills.

Course Outcome: Upon completion of the course the student will be able to

- Analyze the characteristics of synchronous machines and Induction motors
- Perform tests on synchronous machines and Induction motors and evaluate their performance

LIST OF EXPERIMENTS:

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.

2. To perform load test on a three phase induction motor and draw Torque -speed characteristics.

3. To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance in the rotor circuit.

4. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.

5. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.

6. Determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by
   (i) EMF method
   (ii) MMF method.

7. To study synchronization of an alternator with the infinite bus by using:
   (i) dark lamp method
   (ii) two bright and one dark lamp method.

8. To determine V-curves and inverted V-curves of a three phase synchronous motor.

9. To determine Xd and Xq of a three phase salient pole synchronous machine using the slip test and to draw the power-angle curve.

10. Scott connection

EC2806 LINEAR AND DIGITAL ELECTRONIC CIRCUITS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objectives:

- To understand the design of various combinational and sequential circuits and filters.
- To understand the applications of Operational Amplifier as adder, integrator and voltage to current converters.

Course Outcomes:

- The student will be able to design counters, NAND gate and adders.
- The student will be able to design multiplexer, 7-segment LED display and LPF, HPF, BPF
- The student will be able to analyze the application of Operational Amplifier as adder, integrator and voltage to current converters.

LIST OF EXPERIMENTS:

Any TEN of the following experiments

1. Design of a counter asynchronous and synchronous
2. Design of a digital comparator
3. Design of a full adder circuit
4. Design of a multiplexer
5. Design of a 7-segment LED display
6. To study application of Operational Amplifier as adder, integrator and voltage to current converters.
7. To design a low pass filter Second order filters using operational amplifier for cutoff frequency 1 KHz.
8. To design a high pass filter Second order filters using operational amplifier for frequency 12 KHz.
9. To design a band pass filter with unit gain of pass band from 1 KHz to 12 KHz.
10. To study application of Operational Amplifier as voltage comparator.
11. To generate triangular & square wave using operational amplifier.
12. To study regulation of unregulated power supply using IC 7805/7812 voltage regulator and measure the load and line regulations
13. I/O characteristics of a NAND gate

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING RGUKT BASAR

III YEAR
I SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE3101	Electrical Machines-III	4-0-0	4
2	EE3102	Power Systems-II	4-1-0	4
3	EE3103	Power Electronics	4-1-0	4
4	EE3104	Electrical and Electronics Measuring Instruments	4-1-0	4
5	BSBE2001/3001	Environmental Science	4-0-0	3
6	BM3101	Personality Development-II	2-0-0	1
7	EE3701	Electrical & Electronics Measuring Instruments Lab	0-0-3	2
8	EE3702	Control Systems Lab	0-0-3	2

9	EE3703	Electrical Hard Ware Lab	0-0-3	2
10	EE3901	Seminar – III	0-0-3	1
Total Credits				**27**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE3101 ELECTRICAL MACHINES-III

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

- Understand the construction and operating principle of synchronous machine and other special machines
- Understand synchronization of generator with bus bar and parallel operation and load sharing– operation on infinite bus-bar

Course Outcomes:

- Analyze the performance and operating characterstics of synchronous motor and generators.
- Analyze and model reluctance motor, stepper motor, hysteresis motor and universal motors
- Analyze the operation and performance of PMDC and BLDC motors

UNIT - I

Synchronous Machine I

Construction, types, armature winding,winding factors, production of emf, armature reaction, Synchronous reactance,equivalent circuit and phasor diagram- load characteristics, open

circuit and short circuit characterstics. Voltage regulation using synchronous impedance or emf, mmf, Potier triangle and ASA methods.

UNIT -II

Synchronous Machine II

Effect of varying field current at different loads on generator and motor (with phasor diagram), V and inverted V curves. Hunting & damping, Synchronous condenser, starting methods of synchronous motor.

UNIT -III

Synchronous Machine III

Two reaction theory –analysis and its application for the voltage regulation of salient pole alternator, phasor diagram. Slip test,Power flow equations of cylindrical and salient pole machines. Synchronizing power and torque. Parallel operation and load sharing– operation on infinite bus-bar typical applications.

UNIT-IV

AC Series Motors:

Construction, Principle of operation, Phasor diagrams and Characteristics of Single phase and Three Phase AC Series motors, Simple and compensated motors, Universal motors and their Applications**.**

UNIT-V

Special Purpose Machines:

Schrage Motor: Construction, Principle of operation, Speed and power factor control, Applications. Construction and principle of operation of Stepper motors, Permanent magnet DC motors, Brushless DC motors, Tacho generators. Linear Induction motors and their Applications.

Text Books:

1. P.S. Bimbhra, “Generalized Theory of Electrical Machines”, Khanna Publishers
2. D.P.Kothari & I.J.Nagrath, “Electric Machines”, Tata Mc Graw Hill
3. P.S.Bimbhra, “Electrical Machinery”, Khanna Publisher

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery –Sixth Edition TMH 2003.
2. Stephen.J.Chapman: Electric Machinery –Mc Graw Hill International Edition, 2005.
3. J.B.Gupta: Theory and Performance of Electrical Machines, S. K. Kataria & Sons, Fourteenth Edn, 2006.

EE3102 **POWER SYSTEMS-II**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-1-0-4**

Course Objective:

- Analyze transmission line performance
- Apply load compensation techniques to control reactive power
- Understand the application of per unit quantities
- Determine the fault currents for symmetrical and unbalanced faults
- Design over voltage protection and insulation coordination

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

- Analyze circuit parameters of transmission lines & transmission line performance & Solve Problems
- Describe the voltage control methods and different compensation methods available
- Explain the significance of per unit quantities.
- Determine the fault currents for symmetrical and unbalanced faults
- Realize the concept of Traveling waves on transmission line

UNIT- I:

Inductance and Capacitance Calculations of Transmission Lines: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance, Skin and Proximity effect

UNIT- II:

Performance of Transmission Lines : Representation of lines, short transmission lines, medium length lines, nominal T and PI- representations, long transmission lines. The equivalent circuit representation of a long Line, A, B, C, D constants, Ferranti Effect, Power flow through a transmission line, receiving end power circle diagram.

UNIT- III:

Voltage Control : Introduction – methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase modifiers.

Compensation in Power Systems : Introduction - Concepts of Load compensation – Loadability characteristics of overhead lines – Uncompensated transmission line – Symmetrical line – Radial line with asynchronous load – Compensation of lines.

UNIT-IV:

Per Unit Representation of Power Systems : The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system.

Travelling Waves on Transmission Lines : Production of traveling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

UNIT- V:

Symmetrical Components and Fault Analysis: Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks, fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, faults with fault impedance, reactors and their location, short circuit capacity of a bus

Text Books:

1. John J. Grainger & W.D. Stevenson: Power System Analysis – Mc Graw Hill International 1994.
2. C.L. Wadhwa: Electrical Power Systems – New Age International Pub. Co.Third Edition, 2001.
3. D.P. Kothari and I.J. Nagrath, Modern Power System Analysis - Tata Mc Graw Hill Pub. Co., New Delhi, Fourth edition, 2011

Reference Books:

1. Hadi Scadat: Power System Analysis – Tata Mc Graw Hill Pub. Co. 2002
2. W.D. Stevenson : Elements of Power system Analysis – McGraw Hill International Student Edition.
3. Miller “Reactive power control in Electric systems “Wiley , 2/e ,2011

EE3103 POWER ELECTRONICS

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-1-0-4**

Course Objectives:
This course will develop students' knowledge in/on

- Characteristics and applications of basic power semiconductor switches Performance of controlled rectifiers.
- Performance of chopper, inverter operation
- AC voltage controllers & Cyclo converter operation and power electronic applications in industry

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

- Determine the power semiconductor switches characteristics and their applications
- Evaluate the performance of rectifiers. & Solve Problems
- Analyze & describe the operation of inverters and choppers & Solve Problems
- Evaluate the performance of AC voltage controllers and Cyclo-converters

UNIT – I

Characteristics of Power Devices: Introduction of power semi conductor devices like SCR, DIAC, TRAIC, GTO, MOSFET, UJT, IGBT and their characteristics. Two transistor modes of SCR, protection of SCR against over voltages, over current and voltage and current transients.

UNIT – II

Gate Triggering circuits, Resistance, Resistance – capacitance Trigger circuits, UJT as relaxation oscillator, series and parallel operation of SCRs, String efficiency, Different methods of forced communication Techniques

UNIT – III

Phase controlled Rectifiers: Phase Angle control Single phase three phase, halfwave, full wave, Half controlled and Fully controlled with and without free wheeling diodes for resistive and inductive loads, effect of source inductance, Dual converters, Power factor improvements.

UNIT – IV

Choppers: Basic circuit, step-up step-down, classification of choppers on the basis of various quadrants, chopper commutation, Jones and Morgan chopper.

Inverters: Series inverter, parallel inverter, voltage source inverters, and current source inverters, 1-phase and 3-Phase bridge inverters.

UNIT – V

AC Voltage Controllers: Single Phase AC Controllers with R and RL loads, Three Phase AC Voltage Controllers with Star and Delta connected loads.

Cyclo converters: Principle and operation of Single phase to single phase, single phase to 3-phase, 3-phase to 1-phase Cyclo converters.

Industrial Applications: Battery charger, Uninterruptible power supply, Switched mode power supply.

Text Books:

1. M.D. Singh & K.B. Kanchandani, Power Electronics, second edition, Tata McGraw Hill, New Delhi
2. P.S. Bhimbra, 'Power Electronics', 5th edition, Khanna Publishers, New Delhi.

Reference Books:

1. M.H. Rashid, 'Power Electronics, circuits, devices &applications', 3rd edition, Prentice Hall of India, New Delhi.
2. P.C. Sen, 'Power Electronics', Tata McGraw Hill, New Delhi.
3. Ned Mohan Tore M. Undeland: 'Power Electronics: Converters, Applications, and design', 3rd edition, John Wiley & Sons, 2007

EE3104 ELECTRICAL AND ELECTRONICS MEASURING INSTRUMENTS

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To understand the operating principle of various types of analog instruments for measuring voltage, current, power, phase, frequency and energy.
- To determine the circuit parameters using AC and DC bridges.
- To understand operating principles of electronic measuring instruments

Course Outcomes: Upon competition of the course students will be able to

- Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO
- Compute the errors in CTs and PTs.
- Selection of transducers for the measurement of temperature, displacement and strain .

UNIT I
Introduction to Measurement
Methods of measurement, Measurement system, Classification of instrument systems, Characteristics of instruments & measurement systems, Definition of accuracy, precision,

resolution. Speed of response. Errors in measurement& its analysis. Loading effect due to shunt and series connected instruments.

Measurement of current and voltage
General features, Construction, principle of operation and torque equation of Permanent magnet moving coil(PMMC), Moving Iron(MI), electrodynamometer, Induction, Thermoelectric and rectifier type instruments. Extension of instrument ranges using shunt, multipliers.

UNIT II
Measurement of power
Construction and principle of operation of Electrodynamometer type wattmeter. Errors in Electrodynamometer type wattmeter. Low power factor wattmeter. Measurement of power in single phase system.

Measurement of phase,frequency and energy
Single phase and three phase electrodynomometer power factor meter, moving iron power factor meter. Construction and operation of different types of frequency meters. Construction and principle of operation of Single phase induction type energy meters, errors in energy meter and their compensation methods. Testing of energy meter by phantom loading method.

UNIT III
Instrument Transformers
CT and PT; their errors, Applications of CT and PT in the extension of instrument range.

Measurement of resistance
measurement of low resistance by kelvin's double bridge, measurement of medium resistance by wheatstone bridge, voltmeter and ammeter method,substitution method and ohmmeter method.measurement of high resistance by loss of charge method, direct deflection method and Meggar.

Measurement of inductance and capacitance
Measurement of inductance with the help of AC Bridges(Maxwell's Inductance, Anderson, Hay's and owen's bridges)Measurement of capacitance with the help of AC Bridges (De Sauty's, Schering Bridge) their Applications and Limitations. Q meter.

UNIT IV
Potentiometers
Principle of operation and application of Crompton’s DC potentiometer, Polar and co-ordinate type of AC potentiometers. Magnetic Measurement- Ballistic galvanometer, Flux meter, Determination of hysteresis loop, measurement of iron losses.

Sensors & Transducers
Introduction to sensors & transducers,RTD, Thermistors, LVDT, Strain Gauge, Piezoelectric Transducers, Hall effect sensors. Flow measurement using magnetic flow measurement.

UNIT V

Digital Measurement of Electrical Quantities

Advantages of digital instruments. Concept of digital measurement. Block diagram and theory of digital voltmeter, digital Frequency meter, Spectrum analyzer and harmonic distortion analysers.

Block diagram and working of Cathode Ray Oscilloscope, Cathode Ray Tube (CRT) & its components, Applications of CRO in measurement, Lissajous Pattern, Dual trace & dual beam oscilloscopes.

Text Books:

1. A. K. Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai & Sons, India
2. J. B. Gupta, "Electrical Measurement & Measuring Instrument", S. K. Kataria & Sons

Reference Books:

1. E. W. Golding & F. C. Widdis, "Electrical Measurement &Measuring Instrument", A. W.
   Wheeler & Co. Pvt. Ltd. India
2. Forest K. Harris, "Electrical Measurement", Willey Eastern Pvt. Ltd. India

EE3701 ELECTRICAL AND ELECTRONICS MEASURING INSTRUMENTS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objectives:

- To provide students with good depth of knowledge of electrical and electronic measuring instruments.
- To understand measurement errors and non ideal electrical devices.

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

- Calibrate single phase energy meters
- Measure Resistance, Inductance and capacitance using AC and DC bridges
- Measure frequency, voltage peaks, phase difference with an oscilloscope.
- Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO

LIST OF EXPERIMENTS

Any TEN of the following experiments

1. Calibration of voltmeter and ammeter.
2. Calibration of Single phase Energy Meter
3. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor.
4. Measurement of low resistance by Kelvin's double bridge.
5. Measurement of inductance by Maxwell's bridge.
6. Measurement of inductance by Hay's bridge.
7. Measurement of inductance by Anderson's bridge.
8. Measurement of capacitance by Owen's bridge.
9. Measurement of capacitance by De Sauty bridge.
10. Measurement of capacitance by Schering bridge.
11. Measurement of voltage, current and resistance using dc potentiometer.
12. Study of frequency and differential time counter.
13. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
14. 3-phase power measurement by two wattmeter method

EE3702 CONTROL SYSTEMS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objectives

- To strengthen the knowledge of Feedback control
- To inculcate the controller design concepts

Course Objectives

- Students will have knowledge of Feedback control
- Students will have the knowledge of controller Design
- Students will be able to model simple first order systems

Any Eight of the following experiments are to be conducted:

1. Time response of Second order system
2. Characteristics of Synchros
3. Programmable logic controller – Study and verification of truth tables of logic gates, simple Boolean expressions and application of speed control of motor.

4. Effect of feedback on DC servo motor
5. Transfer function of DC motor
6. Effect of P, PD, PI, PID Controller on a second order systems
7. Lag and lead compensation – Magnitude and phase plot
8. Temperature controller using PID
9. Characteristics of magnetic amplifiers
10. Characteristics of AC servo motor

Any two simulation experiments are to be conducted:-

1. Simulation of Op-Amp based Integrator and Differentiator circuits.
2. Linear system analysis (Time domain analysis, Error analysis) .
3. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system
4. State space model for classical transfer function – Verification.

REFERENCE BOOKS:

1. Simulation of Electrical and electronics Circuits using PSPICE – by M.H.Rashid, M/s PHI Publications.
2. PSPICE A/D user's manual – Microsim, USA.
3. PSPICE reference guide – Microsim, USA.
4. MATLAB and its Tool Books user's manual and – Mathworks, USA.

EE3703 Electrical Hardware Lab

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **0-0-3-2**

Course Objective:

- To give practical exposure to the design of electrical devices like DC machines, transformers, Induction motor etc.
- To give practical exposure to the design or repair of home electrical appliances

Course Outcome: Upon completion of the course the student will be able to

- Test and design AC and DC machines winding
- Design proper earthing device to electrical device
- Design a setup to run 3-phase induction motor with 2-phase supply

List of Experiments

1. Electrical house wiring
2. CPU assembling
3. Making of Inductor and capacitor and study their characteristics

4. Electrical earthing to machine or equipment
5. Winding of DC machines
6. Winding of AC machines
7. Testing of the winding of DC and AC Machines
8. Designing of a fault detecting device
9. 2-phase to 3-phase conversion to run a 3-phase induction motor
10. Design of Energy Conversion Devices

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

III YEAR
II SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE3201	Power System Protection	4-0-0	4
2	EE3202	Power Semiconductor Drives	4-0-0	4
3	EC3205	Microprocessors and Microcontrollers	4-0-0	4
4	CS3001	Object Oriented Programming	4-0-0	4
5	BM3001/4001	Managerial Economics and Financial Analysis	4-0-0	4
6	HS3201	Soft Skills-II	2-0-0	1
7	EE3801	Power Electronics Lab	0-0-3	2
8	EE3802	Power Systems Lab	0-0-3	2
9	CS3601	Object Oriented Programming Lab	0-0-3	2

10	EE3000	Comprehensive Viva	0-0-3	1
11	EE3902	Seminar-IV	0-0-3	1
Total Credits				**29**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE3201 POWER SYSTEM PROTECTION

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objective:

- To compare and contrast electromagnetic, static and microprocessor based relays
- To apply technology to protect power system components
- To select relay settings of overcurrent and distance relays.
- To analyze quenching mechanisms used in air, oil and vacuum circuit breakers

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

- Compare electromagnetic with static relays
- Evaluate the of performance of Various Relays
- Understand about the concept of over voltage protection and insulation coordination
- Analyze Fundamental principles of circuit breakers & fuses

UNIT I:

Electromagnetic Relays - Basic Requirements of Relays – Primary and Backup Protection – Construction,Details of – Attracted Armature, Balanced Beam, Inductor Type and Differential Relays – UniversalTorque Equation – Characteristics of Over Current, Direction and Distance Relays. Static Relays –Introduction to static relays, Advantages and Disadvantages over electromagnetic relays

UNIT II:
Protection of Generators Against Stator Faults, Rotor Faults, and Abnormal Conditions. Restricted Earth Fault and Inter-Turn Fault Protection. Numerical Problems On percentage Winding Unprotected. Protection of Transformers: Percentage Differential Protection, Numerical Problem on Design of CT s Ratio, Buchholtz Relay Protection, Numerical Problems.

UNIT III:
Protection of Feeder (Radial & Ring Main) Using Over Current Relays. Protection of transmission Line– 3 Zone Protection Using Distance Relays. Carrier Current Protection. Protection of Bus Bars.

UNIT IV:
Overvoltage Protection and Insulation Coordination: Over voltage due to arcing ground and Peterson coil, lightning, horngaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves.

UNIT V:
Circuit Breakers : Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, Vacuum Circuit Breaker, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers, testing of circuit breakers.
Fuses : Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination

Text Books:

1. Badriram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH 2001
2. U.A.Bakshi, M.V.Bakshi: Switchgear and Protection, Technical Publications, 2009.
3. Switchgear and Protection – by Sunil S Rao, Khanna Publishers, 1992.

Reference Books:

1. L.P.Singh ―Protective relaying from Electromechanical to Microprocessors‖, New Age International
2. “Electrical Power”, by S. L. Uppal, Khanna pulishers,1988.
3. Ravindranath & Chander, “Switch Gear & Protection” New Age International , 2/e, 2014

EE3202 **POWER SEMICONDUCTOR DRIVES**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objectives:

This course will develop students' knowledge in/on

- The fundamentals and dynamics of electric drives
- The various types of the rectifier control and chopper control DC drives
- The AC voltage control, frequency control and slip power recovery control of Induction motor drives.
- Various types of synchronous motor drives and its speed torque characteristics

Course Outcomes: After completion of this course, students will be able to….

- Understand the fundamentals and dynamics of electric drives
- Develop the rectifier control and chopper control DC drives
- Realize the Concept of AC voltage control, frequency control and slip power recovery control of induction motor drives & Solve Problems
- Know the concept of Synchronous motor drives & Solve Problems

UNIT-I

Fundamentals of Electric Drives: Electric Drives, advantages of electric drives, parts of electric drives, choice of electric drives, status of D.C. drives and A.C. drives. starting, Braking, speed control of AC and DC motors

UNIT-II

Dynamics of Electric drives: Fundamental torque equations, types of load, Quadrant diagram of speed-Torque characteristics, Dynamics of load torque combinality, steady state stability and Transient stability of an Electric drives. Load equalization. Calculation of time and energy loss in Transient operation, Drive specifications.

UNIT-III

Rectifier control of dc drives: Controlled rectifier circuits, braking operation of rectifier controlled separately excited dc motor, single phase and three phase half and fully controlled rectifier fed separately excited dc motor ,multi quadrant operation of fully controlled rectifier fed separately excited dc motor.
Chopper control of dc drives : chopper control of separately excited and series dc motors , multi quadrant control of chopper fed motors

UNIT-IV

Control of Induction Motor DrivesAC Voltage Controllers: control of induction motor by AC voltage controllers. Frequency controlled Induction motor drives: control of Induction motor by Voltage Source Inverter (VSI), Current Source Inverter (CSI), Current controlled PWM inverters and cyclo converters.
Slip power controlled wound-rotor induction motor drives: static rotor resistance control, static scherbius drives, krammer drives

UNIT-V

Control of Synchronous Motor Drives Operation of cylindrical rotor synchronous motor from VSI and CSI, self controlled Synchronous Motor Drives using cyclo converters, Permanent magnet AC motor drives

Text Books:

1. G.K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publishers, New Delhi. 1988
2. N.K. De and P.K. Sen, “Electrical Drives”, Prentice Hall of India, New Delhi. 1999

Reference Books:

1. Vedam Subrahmanyam, “Thyristor Control of Electrical Drives”, Tata McGraw Hill, New Delhi. 1988.
2. B.K. Bose “Modern Power Electronics & A.C Drives’.Pearson .edu
3. P.S.Bimbhra “ Power Electronics” Khanna publishers
4. G.K. Dubey, “Power Semiconductor Drives”, Narosa Publishers, New Delhi. 1988

EC3205 MICRO PROCESSORS AND MICRO CONTROLLERS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objective:

- To familiarize with the architecture of 8086 processor, assembling language programming and interfacing with various modules.
- To understand 8051 Microcontroller concepts, architecture, programming and application of Microcontrollers.

Course Outcomes: Upon competition of the course student will be able to

- Write efficient programs in Assembly level language of the 8086 family of microprocessors, 8051 controller with help of instruction set easily.
- Know the techniques of interfacing between the processors and peripheral devices
- Design different real-time projects and they will know use of timers, interrupts and serial communication techniques.

UNIT- I

8086 ARCHITECTURE: Functional Diagram, Register Organization, Addressing modes, Instructions, Functional schematic, Minimum and Maximum mode operations of 8086, 8086 Control signal interfacing, Timing Diagrams.

ASSEMBLY LANGUAGE PROGRAMMMING OF 8086: Assembly Directives, Macro's, Simple Programs using Assembler, Implementation of FOR Loop, WHILE, REPEAT and IF-THEN-ELSE Features.

UNIT-II

I/O INTERFACE: 8255 PPI, Various modes of operations and interface of I/O devices to 8086, A/D, D/A Converter Interfacing.

INTERFACING WITH ADVANCED DEVICES: 8086 System bus structure, Memory and I/O Interfacing with 8086, Interfacing through various IC Peripheral Chips, 8257 (DMA Controller), 8259 (Interrupt Priority Control).

UNIT-III

COMMUNICATION INTERFACE: Serial Communication Standards, USART Interfacing RS-232, IEEE-488, 20mA Current Loop, Prototyping and Trouble shooting, Software Debugging tools, MDS.

UNIT-IV

INTRODUCTION TO MICRO CONTROLLERS: Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, Addressing modes and Instruction set of 8051, Simple Programs using Stack Pointer, Assembly language programming of 8051

INTERRUPTS COMMUNICATION: Interrupts - Timer/Counter and Serial Communication, Programming Timer Interrupts, Programming External H/W interrupts, Programming the serial communication interrupts, Interrupt Priority in the 8051, Programming 8051 Timers, Counters and **Programming.**

UNIT- V

INTERFACING AND INDUSTRIAL APPLICATIONS: Applications of Micro Controllers, Interfacing 8051 to LED's, Push button, Relay's and Latch Connections, Keyboard Interfacing, Interfacing Seven Segment Display, ADC and DAC Interfacing.

TEXT BOOKS

1. Kenneth J Ayala, "The 8051 Micro Controller Architecture, Programming and Applications", Thomson Publishers, 2nd Edition.
2. D.V.Hall, "Micro Processor and Interfacing ", Tata McGraw-Hill.

REFERENCE BOOKS

1. Ajay V. Deshmukh, "Microcontrollers – theory applications", Tata McGraw Hill Companies – 2005.
2. Ray and BulChandi, "Advanced Micro Processors", Tata McGraw Hill.
3. Kenneth J Ayala, "The 8086 Micro Processors Architecture, Programming and Applications", Thomson Publishers, 2005.
4. Liu & Gibson, Microcomputer Systems: The 8086/8088 Family: Architecture, Programming and Design, 2nd edition

EE3801 POWER ELECTRONICS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Learning Objectives:

This laboratory course will develop students' knowledge in/on

- Characteristics of power electronics devices
- Gate firing circuits & commutation circuits for thyristor.
- Control methods of rectifiers, choppers, AC voltage controllers & Inverters.
- Simulation of power electronics circuits.

Course Outcomes:

After completion of this laboratory course, students will be able to

- Determine the power semiconductor switches characteristics and their applications.
- Design gate firing & commutation circuits for SCRs.
- Analyze the operation of converters, inverters and choppers.
- Design and simulate power electronic circuits and plot their characteristics.

Any eight experiments should be conducted

1. Study of Characteristics of SCR, MOSFET & IGBT
2. Gate firing circuits for SCR's
3. Single Phase AC Voltage Controller with R and RL Loads
4. Single Phase fully controlled bridge converter with R and RL loads
5. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
6. DC Jones chopper with R and RL Loads
7. Single Phase Parallel, inverter with R and RL loads
8. Single Phase Cycloconverter with R and RL loads
9. Single Phase Half controlled converter with R load
10. Three Phase half controlled bridge converter with R-load
11. Single Phase series inverter with R and RL loads
12. Single Phase Bridge converter with R and RL loads
13. Single Phase dual converter with RL loads

Any two simulation experiments should be conducted

1. Simulation of single-phase full converter using RLE loads and single-phase AC voltage controller using RLE loads.
2. Simulation of resonant pulse commutation circuit and Buck chopper.
3. Simulation of single phase Inverter with PWM control.

Reference books:

1. M.H.Rashid, Simulation of Electric and Electronic circuits using PSPICE – by M/s PHI Publications.

EE3802 POWER SYSTEMS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objective:

- Performance of long transmission lines and reactive power control
- Characteristics of protective relays
- Short circuit analysis and sequence components of power system elements
- Study of different faults on Transmission lines

Course Outcomes: After completion of this lab, students will be able to

- Determine the performance characteristics of a long transmission line and reactive power control
- Determine the operating characteristics of protective relays
- Compute fault currents and determine the sequence components of power system elements

List of experiments

1. Determination of Sequence Impedances of a cylindrical rotor Synchronous Machine.

2. Fault Analysis (L-G, L-L, L-L-G, L-L-L-G).
3. Determination of Sub transient reactance's of a Salient Pole Synchronous Machine.
4. Characteristics of Over Current Relays.
5. Characteristics of Percentage Biased Differential Relay.
6. Performance and Testing of Generator Protection System.

Any two simulation experiments listed below should be conducted using two electrical related softwares

1. Distribution System Reliability Analysis.
2. Power System Fault Analysis.
3. Transmission Line Fault Analysis.

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

IV YEAR
I SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE4101	Power Systems Operation and Control	4-1-0	4
2	EE4102	Utilization of Electrical Energy	4-0-0	4
3	EE441_	Elective-1	4-0-0	3
4	EE442_	Elective-2	4-0-0	3
5	EC4701	Microprocessors and Microcontrollers Lab	0-0-3	2
6	EE4701	Electrical Simulation Lab	0-0-3	2
7	EE3900	Summer Internship		6
Total Credits				**28**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

EE4101 POWER SYSTEM OPERATION AND CONTROL

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-1-0-4**

Course Objectives:

- To understand the computation of load flows in a power systems
- To study the various methods of reactive power control in power systems and economic load scheduling
- To study load frequency control and its analysis in an isolated power system
- To study stability, stability limits and the dynamics of synchronous machines

Course outcomes: After completion of this course, students will be able to….

- Compute the bus variables and the power flows in the system using various iterative methods
- Determine the optimal economic load scheduling.
- Determine the static and dynamic frequency response of a power system for a single area and two area system
- Predict the stability of power systems and determine the transient stability limits

UNIT – I:

Load flow studies: Introduction, Bus classification, Nodal admittance matrix, Transmission Network Representations: Bus Admittance frame and Bus Impedance frame. Formation of Y_{bus}: Direct and Singular Transformation Methods, Load flow equations, Iterative methods – Gauss, Gauss Seidel and Newton Raphson methods. Newton decoupled and fast decoupled. Merits and Demerits of these methods, system data for load flow study.

UNIT -II :
Economic Operation of Power Systems: Distribution of load between units within a plant, transmission loss as a function of plant generation, calculation of loss coefficients, distribution
of load between plants. Unit commitment: Introduction, constraints in unit commitment problems.

UNIT – III:
Load Frequency control: Introduction, Load frequency problem, Megawatt frequency (or P-F)
control channel, Megavar voltage (or Q – V) control channel. Dynamic interaction between P-F
and Q-V loops, Mathematical model of speed governing system, turbine models division of power system into control areas, P-F control of single control area (the uncontrolled and controlled cases) P-F control of two area systems (the uncontrolled and controlled cases).

UNIT – IV:
Power System Stability: The stability problem, steady state stability limit, Expression using ABCD parameters, steady state stability of synchronous machine. transient stability, swing equation, equal area criterion of stability and its further applications, step by step solution swing equation, some factors affecting transient stability & Methods of improving stability .

Concept of Dynamic stability – effect of excitation on generator power limits.

UNIT – V:
Reactive Power–Voltage Control

Basics of reactive power control. Excitation systems – modeling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node - method of voltage control - tap-changing transformer. System level control using generator voltage magnitude setting, tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

TEXTBOOKS:

1. John Grainger & William Stevenson Jr., “Power Systems Analysis”, McGraw Hill, 1/e,
2. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, 4th Edn, Tata McGraw Hill Education Private Limited 2011.

3. C.L.Wadhwa, Electrical Power Systems, 3rd Edn, New Age International Publishing Co., 2001.

REFERENCE BOOKS:

1. Olle I Elgerd " Electric Energy Systems Theory", Tata McGraw Hill ,2/e ,2011
2. Chakrabarthi, Abhijit halder, "Power system analysis: Operation and Control", Prentice hall of India, 3/e, 2010.

EE4102 UTILIZATION OF ELECTRICAL ENERGY

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-4**

Course Objective

This course will develop students' knowledge in/on

- Various electric traction systems with their performance.
- Selection of motor for different industrial drives.
- Electric heating and welding techniques.
- Designing and selection of lamps for proper illumination

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

- Choose the motor for different types of Electric traction systems.
- Evaluate the selection of a motor for different types of loads.
- Use various heating and welding techniques for different applications.
- Select and design the lamps for proper illumination. & Solve Problems

UNIT – I:

INDUSTRIAL UTILIZATION: Introduction, Factors governing selection of Electric Motors, Nature of electric supply, Types of drives, Nature of loads, Standard Ratings of

Motors, Choice of ratings of Motors, Types of Motors used in industrial Drives, Motors for particular service, speed control.

UNIT – II :

ELECTRIC HEATING: Advantages and methods of electric heating, resistance heating induction heating and dielectric heating.

ELECTRIC WELDING: Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT – III:

ILLUMINATION: Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light.

VARIOUS ILLUMINATION METHODS: Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting.

UNIT –IV:

ELECTRIC TRACTION – I:

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostat braking and regenerative braking.

Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.

UNIT – V:

ELECTRIC TRACTION-II: Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and coefficient of adhesion.

TEXT BOOK:

1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press.
2. Partab, Art & Science of Utilization of electrical Energy –Dhanpat Rai & Sons.

REFERENCE BOOKS:

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

EE4701 ELECTRICAL SIMULATION LAB

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **0-0-3-2**

Course Objective:

- To impart hands on experience in verification of circuit laws and theorems, measurement of circuit parameters, study of circuit characteristics and the simulation of power electronics circuits using PSPICE.
- Gives practical exposure to the usage of different circuits with different condition.
- Acquire skills of using computer packages MATLAB coding and SIMULINK in power Electronics and power system studies.

Course Outcome: Upon the successful completion of this course, the student is expected to gain the following skills:

- Understand the fundamentals and programming Knowledge in PSPICE.
- Able to understand the Transient & Steady State Performance of a system.
- Able to generate plots and export this for use in reports and presentations.
- Able to give practical experience with simulating physical systems

List of Experiments:

Any TEN of the following Experiments

1. Stability analysis(Bode, Root locus, Nyquist) of linear time invariant system
2. Effect P, PD, PI, PID controllers on a second order system
3. Simulation of Half wave & Full wave bridge rectifier .
4. Simulation of single phase bridge inverter
5. Simulation of Boost Converter
6. Performance evaluation of medium and long transmission lines .
7. Symmetrical component analysis
8. Load frequency control of single area and two area power system
9. Performance of FC-TCR compensator
10. Permanent Magnet DC motor simulation
11. Newton Raphson method of load flow analysis.
12. Gauss seidal method of load flow analysis.
13. Fault analysis

Reading:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.
3. Control Systems Engineering-I.J. Nagrath & M.Gopal- New Age International Pub. Co
4. A.E. Clayton & C.I. Hancock Performance and Design of DC Machines.

EC4701 MICROPROCESSOR AND MICROCONTROLLERS LAB

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **0-0-3-2**

Course Objective:

- To familiarize with the TITAN II Kit's hardware, usage of Triton IDE.
- To understand the interfacing with interfacing with various modules.

Course Outcome:

- The student will be able to interface Keyboard, stepper motor and DC motor.
- The student will be able to interface traffic light, ADC and DAC.
- The student will be able to understand 8051 Microcontroller concepts, architecture, programming and application of Microcontrollers.

LIST OF EXPERIMENTS:

1. Familiarization with TITAN II Kit's hardware and usage of Triton IDE along with Flash Magic for dumping the code to the controller by blinking on board LEDs.

2. Interface simple seven segment LED display with controller.
3. To Display “DEPT OF EEE” on LCD in 8-bit as well as 4-bit mode
4. Interface Keyboard and LCD with controller.

- Interface Stepper Motor by controlling its direction and make it spin faster or slower.
- Interface DC motor and control its speed using PWM technique.
- Interface Elevator to the controller.
- Interface Traffic Light with controller.
- Interfacing ADC to Microcontroller.
- Interface DAC with Microcontroller and generate multiple waveforms.
- Interface Temperature Sensor to ADC and measure it on LCD with microcontroller.

CURRICULUM OF ELECTRICAL AND ELECTRONICS ENGINEERING
RGUKT BASAR

IV YEAR
II SEMESTER

S.No	Subject Code	Subject Name	L-T-P	C
1	EE451_	Elective-3	4-0-0	3
2		Free Elective-1	4-0-0	3
3	EE4000	Comprehensive Viva		1
4	EE4800	Project	0-12	12
Total Credits				**19**

L-Lectures, T-Tutorials, P-Practicals, C-Credits

List of Electives:

Electives can be taken from any of the courses being offered which are expected to be a sub set of the list Electives given here.

Some of the electives also can be taken from the relevant ones from those being from other departments with the approval of the Head of the department

EE4411: RENEWABLE ENERGY SYSTEMS

EE4412: COMPUTER METHODS IN POWER SYSTEMS

EE4413: POWER QUALITY

EE4414: POWER SYSTEM DEREGULATION

EE4421: HIGH VOLTAGE ENGINEERING

EE4422: ARTIFICIAL NEURAL NETWORKS AND FUZZY SYSTEMS

EE4423: SPECIAL MACHINES

EE4424: DIGITAL CONTROL SYSTEMS

EE4425: HVDC TRANSIMISSION

EE4531: SWITCH MODE POWER SUPPLIES

EE4532: SMART GRID

EE4533: RELIABILITY ENGINEERING

EE4534: FELXIBLE AC TRANSMISSION SYSTEMS

EE4411 RENEWABLE ENERGY SYSTEMS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course Objectives:

- To understand the basic aspects of renewable energy supply presenting fundamental characteristics of resource base (solar radiation, wind energy..etc).
- To understand the issues related to energy supply systems.

Course Outcomes: Upon the successful competition the course, the student will be able to

- Understand the principles of wind power and solar photovoltaic power generation, fuel cells.
- Assess the cost of generation for conventional and renewable energy plants.
- Analyze the issues involved in the integration of renewable energy sources to the grid.

UNIT-I

Introduction:
Renewable Sources of Energy-Grid-Supplied Electricity-Distributed Generation(DG)-Purpose, Sizing and Sitting, Optimal Location, DG Influence on Power and Energy Losses – Microgrid(MG)-Renewable Energy Economics-Calculation of Electricity Generation Costs – Demand side Management Options –Supply side Management Options- Modern Electronic Controls of Power Systems.

UNIT-II
Photovoltaic Power Plants:
Solar Energy-Generation of Electricity by Photovoltaic Effect -Dependence of a PV Cell Characteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and Parameters for Photovoltaic Panels-Photovoltaic Systems-Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy. Types power converters used in solar systems

UNIT-III
Wind Power Plants:
Appropriate Location -Evaluation of Wind Intensity -Topography -Purpose of the Energy Generated -General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines - Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind Power Energy - Analysis of Small Generating Systems. Types of generators and converters used in wind energy systems

UNIT-IV
Energy Storage Systems
Energy Storage Parameters-Lead–Acid Batteries-Ultra Capacitors-Flywheels - Superconducting Magnetic Storage System-Pumped Hydroelectric Energy Storage Compressed Air Energy Storage -Storage Heat -Energy Storage as an Economic Resource.

UNIT-V
Integration and Interconnection of Alternative Sources of Energy:
Principles of Power Injection-Instantaneous Active and Reactive Power Control Approach-Integration of Multiple Renewable Energy Sources-Islanding and Interconnection Control-DG Control and Power Injection. Interconnection Technologies with Grid.

T**EXT BOOKS:**

1. Felix A. Farret, M. Godoy Simoes, “Integration of Alternative Sources of Energy”, John Wiley & Sons, 2006.
2. B.H.Khan:Non-conventional energy Resources McGraw Hill Education India private limited, 2013.

REFERENCE BOOKS

1. Solanki: Renewable Energy Technologies: Practical Guide For Beginners, PHI Learning Pvt. Ltd., 2008.
2. D.Mukherjee: Fundamentals Of Renewable Energy Systems, New Age International publishers, 2007.
3. Remus Teodorescu, Marco Liserre, Pedro Rodríguez: Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

4. Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004

EE4412 COMPUTER METHODS IN POWER SYSTEMS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course Objectives:

- To impart in-depth knowledge on different methods of power flow solutions.
- To perform optimal power flow solutions in detail.
- To analyze the short circuit analysis and Stability analysis.

Course Outcomes: Upon the successful competition the course, the student will be able to

- **Formulate** the incidence, network matrices and **model** the power system components.
- Understand application of Gauss-Seidel, Newton-Raphson and Fast **De**coupled methods.
- Perform short circuit fault analysis and understand the consequence of different type of faults.

UNIT-I:
POWER SYSTEM NETWORK MATRICES

Graph Theory: Definitions and Relevant concepts in Graph Theory, Network Matrices. Transmission Network Representations: Bus Admittance frame and Bus Impedance frame. Formation of Y_{bus}: Direct and Singular Transformation Methods, Numerical Problems. Formation of Z_{Bus}: Modification of existing Z_{Bus} Matrix for addition of a new branch, & complete Z_{Bus} building algorithm Numerical Problems.

UNIT–II:
POWER FLOW STUDIES-I

Introduction: Necessity of Power Flow Studies, Bus classification and Notations, Convergence & Bus mismatch criterias. Load Flow Methods: Gauss-Seidal Method in complex form without & with voltage control buses, line flows and loss calculations, Newton Raphson method in Polar and Rectangular form, derivation of Jacobian elements, Numerical Problems for one or two iterations.

UNIT–III:
POWER FLOW STUDIES-II

Introduction to sensitivity & decoupled submatrices of J-matrix, Decoupled load flow method and its assumptions, Fast Decoupled load method and its assumptions, Comparison of Different Methods – DC load Flow method, Numerical problems for one or two iterations.

UNIT–IV:
SHORT CIRCUIT ANALYSIS

Per-Unit Systems. Per-Unit equivalent reactance network of a three phase Power System, Numerical Problems. Symmetrical fault Analysis: Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors, Numerical Problems. Symmetrical Components, sequence impedances and networks, Numerical Problems. Unsymmetrical Fault Analysis: Fault current calculations for LG, LL, LLG faults with and without fault impedance, Numerical Problems.

UNIT–V:
POWER SYSTEM STABILITY ANALYSIS

Introduction to Power System Stability issues. Rotor dynamics & Swing equation, Power angle equation with & without neglecting line resistance, Steady State Stability, Determination of Transient Stability through Equal Area Criterion for single machine infinite system, Critical clearing angle & time, Numerical problems. Multi-machine transient analysis: Classical representation of system and its assumptions, Solution of Swing Equation by Point-by-Point Method, Methods to improve Stability.

Reference books:

1. M.A.Pai,Computer Techniques in Power System Analysis, TMH Publications
2. Grainger and Stevenson, Power System Analysis, Tata McGraw Hill.
3. K.Uma rao, Computer Techniques and Models in Power Systems, I.K. International.
4. Hadi Saadat, Power System Analysis, TMH Edition.

EE4413 **POWER QUALITY**

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Course Objectives:

- This course mainly focuses on the various power quality issues, monitoring and the enhancement of the power quality.

Course Outcomes:

- Learn to distinguish between the various categories of power quality problems.
- Ability to explain power quality disturbances and typical problems associated with power quality disturbances.
- **Identify** the harmonic sources and the effects of harmonic distortion.

- Ability to explain the typical equipment that either causes or is susceptible to electrical power quality disturbances.

UNIT I
Introduction
Definition of Power Quality- Power Quality Terminology – Classification of Power Quality Issues- Magnitude Versus Duration Plot - Power Quality Standards - Responsibilities of The Suppliers and Users of Electric Power-CBEMA and ITIC Curves.

UNIT II
Transients, Short Duration And Long Duration Variations
Categories and Characteristics of Electromagnetic Phenomena in Power Systems-Impulsive and
Oscillatory Transients-Interruption - Sag-Swell-Sustained Interruption - Under Voltage – Over Voltage– Outage. Sources of Different Power Quality Disturbances- Principles of Regulating the Voltage- Conventional Devices for Voltage Regulation.

UNIT III
Fundamentals Of Harmonics & Applied Harmonics
Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Qualities Under Non Sinusoidal Conditions, Harmonic Indices, Harmonic Sources From Commercial Loads, Harmonic Sources From Industrial Loads. Applied Harmonics: Effects Of Harmonics, Harmonic Distortion Evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion.

UNIT IV
Power Quality Monitoring
Power Quality Benchmarking-Monitoring Considerations- Choosing Monitoring Locations-Permanent Power Quality Monitoring Equipment-Historical Perspective of Power Quality Measuring Instruments- Power Quality Measurement Equipment-Types of Instruments-Assessment of Power Quality, Measurement Data- Power Quality Monitoring Standards.

UNIT V
Power Quality Enhancement Using Custom Power Devices
Introduction to Custom Power Devices-Network Reconfiguring Type: Solid State Current Limiter (SSCL) -Solid State Breaker (SSB) -Solid State Transfer Switch (SSTS) - Compensating Type: Dynamic Voltage Restorer (DVR)-Unified Power Quality Conditioner(UPQC)-Principle of Operation Only.

Text Books:

1. Electrical Power Systems Quality, Roger C. Dugan, Mark F. McGranaghan, Surya Santoso,
2. H.Wayne Beaty, 2nd Edition, TMH Education Pvt. Ltd., 2008.
3. Power quality by C. Sankaran, CRC Press, 2002.

Reference Books:
1. Understanding Power quality problems by Math H. J. Bollen IEEE Press, 2007.
2. Power quality enhancement using custom power devices by Arindam Ghosh,Gerard Ledwich, Kluwer academic publishers, 2002.

EE4414 **POWER SYSTEM DEREGULATION**

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Course Objectives:

- To understand the basics of deregulation and its benefits
- To learn the role of ISO
- To know the transmission services and it's pricing
- To acquire knowledge on security and congestion management

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

- Understand how the Power Market operates in a deregulated Electrical Power Industry.
- Know the significance of generation planning and transmission planning for power system reliability and security assessment.
- Analyze and distinguish load forecasting and price forecasting methods
- Analyze the power system reliability and security assessment under deregulated

environmental.

UNIT I

Deregulation Of Electric Utilities :

Introduction – Traditional central utility model, reform motivations, separation of ownership and Operation, competition and direct access in the electricity market, independent system operator (ISO), retail electric providers, different experiences.

UNIT II

Competitive Wholesale Electricity Markets & Transmission Open Access

Introduction, ISO, wholesale electricity market characteristics, market model, challenges, trading arrangements, the pool and bilateral trades, multi lateral trades.

UNIT III

Transmission Cost Allocation Methods:

Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

UNIT IV

Market Power & Ancillary Services Management :

Introduction - Different types of market Power – Mitigation of Market Power – Examples - Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

UNIT V

Available Transfer Capability (ATC) : Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow - Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

Text Books:

1. Power System Restructuring and Deregulation, Loi Lei Lai, John Wiley & Sons Ltd., England, 2001.

Reference Books:

1. Operation of Restructured Power System, Kankar Bhattacharya, Math H.J. Boller and Jaap E.Daalder, Kulwer Academic Publishers, 2001.
2. Restructured Electrical Power Systems, Mohammad Shahidehpour and Muwaffaq alomoush, Marcel Dekker, Inc., 2001.

EE4421 **HIGH VOLTAGE ENGINEERING**
Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Course Objectives:

- To develop knowledge on generation of high voltage DC, AC (power frequency and high frequency), impulse voltages and currents
- To know the measurement of high voltages DC, AC (power frequency and high frequency), impulse voltages and currents
- To understand thoroughly various high voltage testing techniques of power apparatus and Insulation coordination in power systems

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

- Understand breakdown phenomena in gases and to elucidate the concepts used for the generation of high voltages and currents.
- Elucidate the concepts used for the measurement of high voltages and currents and design corresponding circuits.

- Understand high voltage testing techniques of Power apparatus and causes of over voltage in Power systems.
- Design the layout of Gas Insulated substations and to know the concepts of insulation coordination.

UNIT – I

INTRODUCTION TO HIGH VOLTAGE TECHNOLOGY AND APPLICATIONS: Electric Field Stresses, Gas / Vacuum as Insulator, Liquid Dielectrics, Solids and Composites, Estimation and Control of Electric Stress, Numerical methods for electric field computation, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings.

UNIT – II

BREAK DOWN IN GASEOUS AND LIQUID DIELECTRICS: Gases as insulating media, collision process, Ionization process, Townsend's criteria of breakdown in gases, Paschen's law - Liquid as insulator, pure and commercial liquids - breakdown in pure and commercial liquids.

BREAK DOWN IN SOLID DIELECTRICS: Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, solid dielectrics used in practice.

UNIT – III

GENERATION OF HIGH VOLTAGES AND CURRENTS: Generation of High Direct Current Voltages, Generation of High alternating voltages, Generation of Impulse Voltages, Generation of Impulse currents, Tripping and control of impulse generators.

MEASUREMENT OF HIGH VOLTAGES AND CURRENTS: Measurement of High Direct Current voltages, Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements.

UNIT – IV

NON-DISTRUCTIVE TESTING OF MATERIAL AND ELECTRICAL APPARATUS: Measurement of D.C Resistivity, Measurement of Dielectric Constant and loss factor, Partial discharge measurements.

HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS: Testing of Insulators and bushings, Testing of Isolators and circuit breakers, testing of cables, Testing of Transformers, Testing of Surge Arresters, and Radio Interference measurements.

UNIT – V

OVER VOLTAGE PHENOMENON AND INSULATION CO-ORDINATION: Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage and Extra High Voltage power systems.

TEXT BOOKS

1. M.S.Naidu and V. Kamaraju , High Voltage Engineering by– TMH Publications, 3rd Edition
2. E.Kuffel, W.S.Zaengl, J.Kuffel , High Voltage Engineering: Fundamentals by Elsevier, 2nd Edition.

REFERENCE BOOKS

1. C.L.Wadhwa , High Voltage Engineering by, New Age Internationals (P) Limited, 1997.
2. Ravindra Arora, Wolfgang Mosch, High Voltage Insulation Engineering by, New Age International (P) Limited, 1995.
3. Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, Roshdy Radwan , Marcel Dekker High Voltage Engineering, Theory and Practice.

EE4422 ARTIFICIAL NEURAL NETWORKS AND FUZZY SYSTEMS

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course Objectives:

- To introduce the basics of Neural Networks and its architectures.
- To introduce the Fuzzy sets and Fuzzy Logic system components
- To deal with the applications of Neural Networks and Fuzzy systems

Course Outcomes: After this course, the student will be able

- To understand artificial neural network models and their training algorithms

- To understand the concept of fuzzy logic system components, fuzzification and defuzzification
- To applies the above concepts to real-world problems and applications.

UNIT – I

INTRODUCTION TO NEURAL NETWORKS: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.

Essentials of Artificial Neural Networks: Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

UNIT–II

FEED FORWARD NEURAL NETWORKS: Single Layer Feed Forward Neural Networks: Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.

Multilayer Feed forward Neural Networks: Credit Assignment Problem, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

UNIT - III

ASSOCIATIVE MEMORIES: Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory).

Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem.

Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network.

UNIT – IV

CLASSICAL AND FUZZY SETS: Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions.

UNIT – V

FUZZY LOGIC SYSTEM: Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

TEXT BOOKS

1. Rajasekharan and Pai, Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications– PHI Publication.

2. Satish Kumar , Neural Networks, TMH, 2004.

REFERENCE BOOKS

1. James A Freeman and Davis Skapura, Neural Networks, Pearson Education, 2002.

2. Simon Hakins, Neural Networks, Pearson Education.

3. C..Eliasmith and Ch. Anderson, Neural Engineering, PHI.

EE4423 SPECIAL MACHINES

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Course Objectives:

- To understand the working principle and construction of stepper motors and switched reluctance motors.
- Demonstrate the ability to understand the construction of ,Amplidyne ,Metadyne and Regulex- third brush generator
- To gain knowledge in principle of operation and characteristics of permanent magnet Brushless dc motors and linear induction motor.

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

- Identify the different features of special machines.

- Perform and analyze different methods to find Torque Pulsations for 180 degrees pole arc and 120 degree current sheet Brushless dc motors
- Elucidate the working and characteristics of stepper motors, VRSM motor and PMMM motor.

UNIT-I

SPECIAL TYPES OF D.C MACHINES-I

Series booster-Shunt booster-Non-reversible boost-Reversible booster

SPECIAL TYPES OF DC MACHINES –II

Armature excited machines—Rosenberg generator- The Amplidyne and metadyne— Rototrol and Regulex-third brush generator-three-wire generator-dynamometer.

UNIT -II

STEPPER MOTORS

Introduction-synchronous inductor (or hybrid stepper motor), Hybrid stepping motor, construction, principles of operation, Energisation with two phase at a time- essential conditions for the satisfactory operation of a 2-phase hybrid step motor- very slow- speed synchronous motor for servo control-different configurations for switching the phase windings-control circuits for stepping motors-an open-loop controller for a 2-phase stepping motor.

UNIT-III

VARIABLE RELUCTANCE STEPPING MOTORS

Variable reluctance (VR) Stepper motors, single-stack VR step motors, Multiple stack VR motors-Open-loop control of 3-phase VR step motor-closed-Loop control of step motor, discriminator (or rotor position sensor) transilator, major loop-characteristics of step motor in open-loop drive – comparison between open-loop position control with step motor and a position control servo using a conventional (dc or ac) servo motor- Suitability and areas of application of stepper motors-5- phase hybrid stepping motor-single phase-stepper motor, the construction, operating principle torque developed in the motor.

SWITCHED RELUCTANCE MOTOR

Introduction – improvements in the design of conventional reluctance motors- Some distinctive differences between SR and conventional reluctance motors-principle of operation of SRM- Some design aspects of stator and rotor pole arcs, design of stator and rotor and pole arcs in SR motor-determination of $L(\theta)$--- θ profile –power converter for SR motor-A numerical example –Rotor sensing mechanism and logic control, drive and power circuits, position sensing of rotor with Hall problems—derivation of torque expression, general linear case.

UNIT –IV

PERMANENT MAGNET MATERIALS AND MOTORS

Introduction, Hysteresis loops and recoil line- stator **frames (pole and yoke - part)** of conventional PM dc Motors, Equivalent circuit of a PM-Development of Electronically commutated dc motor from conventional dc motor.

BRUSHLESS DC MOTOR

Types of construction – principle of operation of BLDM- sensing and switching logic scheme, sensing logic controller, lockout pulses –drive and power circuits, Base drive circuits, power converter circuit-Theoretical analysis and performance prediction, modeling and magnet circuit d-q analysis of BLDM -transient analysis formulation in terms of flux

linkages as state variables-Approximate solution for current and torque under steady state – Theory of BLDM as variable speed synchronous motor (assuming sinusoidal flux distribution)- Methods or reducing Torque Pulsations, 180 degrees pole arc and 120 degree current sheet.

UNIT-V
LINEAR INDUCTION MOTOR
Development of a double sided LIM from rotary type IM- A schematic of LIM drive for electric traction development of one sided LIM with back iron-field analysis of a DSLIM fundamental assumptions.

TEXT BOOKS

1. K.Venkataratnam, Special electrical machines, university press.
2. R.K. Rajput - Electrical machines - 5th edition.
3. V.V. Athani - Stepper motor: Fundamentals, Applications and Design, New age International publishers.

EE4424 DIGITAL CONTROL SYSTEMS

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Course Objectives:

- This course introduces the concepts of Digital control systems and different types of Z-Transforms
- It discusses the design of different controllers, state equations of discrete data systems and stability analysis of discrete systems

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

- **Analyze** discrete control systems using z-transforms and stability of discrete control systems
- **Design** discrete control systems via pole placement
- **Design** observers for discrete control systems

UNIT - I

INTRODUCTION TO DIGITAL CONTROL SYSTEMS AND Z-TRANSFORMS: Introduction - Merits and Demerits of Digital Control Systems - Practical aspects of the choice of sampling rate and Multirate sampling - Basic discrete time signals - Quantization – Sampling Theorem - Data Conversions and Quantization - Sampling process - Mathematical Modeling - Data Reconstruction and Filtering of sampled signals - Zero - Order Hold (ZOH). z- Transform and Inverse z-Transform, Relationship between s - plane and z - plane - Difference equation - Solution by recursion and z-Transform - Pulse Transfer Functions of the ZOH and relationship between G(s) and G(z) - Bilinear Transformation .

UNIT- I

INPUT/OUTPUT ANALYSIS OF DIGITAL CONTROL SYSTEMS: Pulse transfer function - z transform analysis of open loop, closed loop systems - Modified z Transform - transfer function - Stability of linear digital control systems - Stability tests – Jury Stability test.

Root loci - Frequency domain analysis - Bode plots - Gain margin and phase margin.

UNIT – III

DESIGN OF CONTROLLERS FOR I/O MODEL DIGITAL CONTROL SYSTEMS: Cascade and Feedback Compensation by continuous data controllers - Digital controllers - Design using Bilinear Transformation - Realization of Digital PID controllers, Design of Digital Control Systems based on Root Locus Technique.

UNIT – IV

STATE SPACE ANALYSIS AND STATE FEEDBACK CONTROL DESIGN OF DIGITAL CONTROL SYSTEMS: State Equations of discrete data systems, solution of discrete state equations, State Transition Matrix: Computation methods for State Transition Matrix: z - transform method - Relation between State Equations and Pulse Transfer Functions.

Concepts on Controllability and Observability - Pole placement design by state feed back.

UNIT V

DIGITAL STATE OBSERVER AND STABILITY ANALYSIS

Design of the full order and reduced order state observer, Design of Dead beat Controller - some case studies - Stability analysis of discrete time systems based on Lyapunov approach.

TEXT BOOKS

1. K. Ogata, Discrete Time Control Systems, PHI/Addison - Wesley Longman Pte. Ltd., India, Delhi, 1995.
2. B.C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

REFERENCE BOOKS

1. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison - Wesley Longman, Inc., Menlo Park, CA , 1998.
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, India, 1997.

- C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw Hill, 1985.
- John S. Baey, Fundamentals of Linear State Space Systems, McGraw Hill, 1st edition.

- Bernard Fried Land, Control System Design, McGraw Hill, 1st edition.
- Dorsay, Continuous and Discrete Control Systems, McGraw Hill.

EE4425 **HVDC TRANSIMISSION**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course objectives:

- To understand the concept, planning of DC power transmission and comparison with AC Power transmission.
- To analyze HVDC converters.
- To study about the HVDC system control.
- To analyze harmonics and design of filters.
- To model and analysis the DC system under study state.

Course Outcomes: Upon competition of the course the student will be able to

- **Identify significance of** DC over AC transmission system, types and application of HVDC links in practical power systems.

- Understand operating principles of HVDC systems and control aspects.
- **Model** AC/DC system and apply protection for HVDC system against transient overvoltage and over currents

UNIT-I

Basic Concepts: Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links Apparatus required for HVDC Systems**,** Comparison of AC & DC Transmission, Application of DC Transmission System Planning & Modern trends in D.C. Transmission.

UNIT-II

Analysis of HVDC Converters: Choice of Converter configuration analysis of Graetz circuit characteristics of 6Pulse&12Pulseconverters Cases of two 3phase converters in star star mode their performance.

Converter & HVDC System Control: Principle of DC Link Control, Converters Control Characteristics, Firing angle control, Current and extinction angle control, Effect of source inductance on the system; Starting and stopping of DC link; Power Control**.**

UNIT-III

Reactive Power Control In HVDC: Reactive Power Requirements in steady state-Conventional control strategies- Alternate control strategies-sources of reactive power-AC Filters shunt capacitors- synchronous condensers.

Power Flow Analysis In AC/DC Systems: Modeling of DC Links - DC Network - DC Converter - Controller Equations Solution of DC load flow P**.**U. System for D.C quantities-solution of AC-DC Power flow-Simultaneous method-Sequential method.

UNIT-IV

Converter Fault & Protection: Converter faults, protection against over current and over voltage in converter station, surge arresters, smoothing reactors, DC breakers, Audible noise-space charge field-corona effects on DC lines-Radio interference.

UNIT-V

Harmonics: Generation of Harmonics Characteristics of harmonics, calculation of AC Harmonics, Non- Characteristics of harmonics, adverse effects of harmonics Calculation of voltage & Current harmonics Effect of Pulse number on harmonics

Filters: Types of AC filters, Design of Single tuned filters Design of High pass filters.

Text Books

- K.R. Padiyar"HVDC Power Transmission Systems: Technology and system Interactions" New Age International(P) Limited, and Publishers.
- S.S. Rao"EHVAC and HVDC Transmission Engineering and Practice"

Reference Books

1. E.W. Kimbark "HVDC Transmission Direct Current Transmission" John Wiley & Sons.
2. S.Kamakshaiah and V.Kamaraju, 'HVDC Transmission', 1 st Edition, Tata McGraw Hill, 2011.

- E.Uhlmann "Power Transmission by Direct Current" B.S.Publications.

EE4531 SWITCH MODE POWER SUPPLIES

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Course Objectives:

- This course introduces the basic concepts of switched mode power supplies, working of SMPS and different types of converters.
- The course discusses multiple output Fly back SMPS, uses of semiconductors in switched mode topology and different types of switched mode variable power supplies.

Course Outcomes: At the end of the course the student would able to:

- Know the operation of SMPS, importance of semiconductors in SMPS and different types of SMPS
- Analyze different types of converters, the process of Rectification and different types of switched mode variable power supplies

UNIT - I

Switched Mode Power Conversion: Introduction to Switched Mode Power Supply**,** Linear DC to DC Power converters, Non- Idealities in reactive elements, Design of Inductors, Design of Transformers- Copper loss , Power factor, Non-isolated topologies, Isolated topologies, Quasi-resonant zero-current/zero-voltage switch Operating principle of Non-Isolated DC to DC power Converters (Buck, Boost, Buck-Boost, and Cuk) Equivalent circuit model of the non-isolated DC-DC converters. Isolated converters (forward, Flyback).

UNIT - II

Multiple Output Flyback Switch Mode Power Supplies: Introduction, operating Modes, operating principles, Direct off line Flyback Switch Mode Power Supplies, Flyback converter, snubber network, Problems.

UNIT – III

Using Power Semiconductors in Switched Mode Topologies: Introduction to Switched Mode Power Supply Topologies, The Power Supply Designer's Guide to High Voltage Transistors, Base Circuit Design for High Voltage Bipolar Transistors in Power Converters, Isolated Power Semiconductors for High Frequency Power Supply Applications

UNIT - IV

Rectification: Explanation, Advantages and disadvantages, SMPS and linear power supply comparison, Theory of operation , Input rectifier stage, Inverter stage, Voltage converter and output rectifier, Regulation, An Introduction to Synchronous Rectifier Circuits using Power MOS Transistors

UNIT – V

Switch mode variable power supplies: Introduction, variable SMPS techniques, operating principles, practical limiting factors, Efficiency and EMI Applications.

Resonant Power Supplies: An Introduction to Resonant Power Supplies, Resonant Power Supply Converters - The Solution for Mains Pollution Problems.

TEXT BOOKS:

1. "Switch Mode Power Supplies" by Keith H. Billings Taylor Morey- Tata McGraw-Hill

   Publishing Company, 3rd edition.
2. "Switch Mode Power Supplies", Robert W. Erickson.

REFERENCE BOOKS:

1. Switching Power Supplies A-Z, Second Edition- Sanjaya Maniktala.
2. Steven M. Sandler, Switch Mode Power Supplies, Tata McGraw Hill.

EE4532 **SMART GRID**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course Objectives:

- This course introduces the basic concepts of a Smart Grid, different types of constraints and different types of communication technologies for Smart Grid
- It introduces different types of Security systems for the Smart grid
- This course discusses the smart metering and distribution system modeling

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

- Understand the background for Smart Grid and have knowledge about important Terminologies
- Know about challenges and possibilities related to Smart Meters
- Analyze and perform basic design of Smart Grid electric power systems
- The course discusses the interaction between the power grid and Flexible resources and Smart Meters

UNIT I
THE SMART GRID
Introduction, Ageing Assets and Lack of Circuit Capacity, Thermal Constraints, Operational Constraints, Security of Supply, National Initiatives, Early Smart Grid Initiatives, Active Distribution Networks, Virtual Power Plant, Other Initiatives and Demonstrations, Overview of The Technologies Required for The Smart Grid.

UNIT II
COMMUNICATION TECHNOLOGIES
Data Communications: Introduction, Dedicated and Shared Communication Channels, Switching
Techniques, Circuit Switching, Message Switching, Packet Switching, Communication Channels, Wired Communication, Optical Fibre, Radio Communication, Cellular Mobile Communication, Layered Architecture and Protocols, The ISO/OSI Model, TCP/IP
Communication Technologies: IEEE 802 Series, Mobile Communications, Multi Protocol Label
Switching, Power line Communication, Standards for Information Exchange, Standards For Smart Metering, Modbus, DNP3, IEC61850

UNIT III
INFORMATION SECURITY FOR THE SMART GRID
Introduction, Encryption and Decryption, Symmetric Key Encryption, Public Key Encryption,
Authentication, Authentication Based on Shared Secret Key, Authentication Based on Key Distribution Center, Digital Signatures, Secret Key Signature, Public Key Signature, Message Digest, Cyber Security Standards, IEEE 1686: IEEE Standard for Substation Intelligent Electronic Devices(IEDs) Cyber Security Capabilities, IEC 62351: Power Systems Management And Association Information Exchange – Data and Communication Security.

UNIT IV
SMART METERING AND DEMAND SIDE INTEGRATION
Introduction, smart metering – evolution of electricity metering, key components of smart metering, smart meters: an overview of the hardware used – signal acquisition, signal conditioning, analogue to digital conversion, computation, input/output, and communication. Communication infrastructure and protocols for smart metering- Home area network, Neighbourhood Area Network, Data Concentrator, meter data management system, Protocols for communication. Demand Side Integration- Services Provided by DSI, Implementation of DSI, Hardware Support, Flexibility Delivered by Prosumers from the Demand Side, System Support from DSI.

UNIT V
TRANSMISSION AND DISTRIBUTION MANAGEMENT SYSTEMS
Data Sources, Energy Management System, Wide Area Applications, Visualization Techniques, Data Sources and Associated External Systems, SCADA, Customer Information System, Modelling and Analysis Tools, Distribution System Modelling, Topology Analysis, Load Forecasting, Power Flow Analysis, Fault Calculations, State Estimation, Applications, System Monitoring, Operation, Management, Outage Management System, Energy Storage

Technologies, Batteries, Flow Battery, Fuel Cell and Hydrogen Electrolyser, Flywheels, Superconducting Magnetic Energy Storage Systems, Supercapacitors.

Text Books:

1. Smart Grid, Janaka Ekanayake, Liyanage, Wu, Akihiko Yokoyama, Jenkins, Wiley Publications, 2012.
2. Smart Grid: Fundamentals of Design and Analysis, James Momoh, Wiley, IEEE Press., 2012.

EE4533 RELIABILITY ENGINEERING

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course Objectives:

- The course covers principles of reliability, failure rate and its relation to reliability, probability distribution of the time to failure, exponential and weibull distributions, reliability of systems, series and parallel systems, stand by redundancy, systems mean time to failure, mean residual life, reliability in design.

- It also includes failure mode effect analysis, failure tree analysis, reliability testing and analysis, and warranty problems.

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

- Have a working knowledge of the techniques of reliability engineering

- To apply learned concepts to improving the maintenance, the maintainability, hazard risk and the safety of a plant.
- Develop warranty plans for different products
- To carry out a failure mode effect and criticality analysis.

UNIT – I

Basic Probability Theory: Elements of probability, probability distributions, Random variables, Density and Distribution functions- Binomial distribution- Expected value and standard deviation - Binomial distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution.

Definition of Reliability: Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models - Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time Between Failures.

UNIT – II

Network Modeling And Evaluation Of Simple Systems: Basic concepts- Evaluation of network Reliability / Unreliability - Series systems, Parallel systems - Series-Parallel systems- Partially redundant systems- Examples.

Network Modeling and Evaluation of Complex systems: Conditional probability method- tie set, Cutset approach- Event tree and reduced event tree methods- Relationships between tie and cutsets- Examples.

UNIT – III

Time Dependent Probability: Basic concepts- Reliability function f(t). F(t), R(t) and h(t) - Relationship between these functions.

Network Reliability Evaluation Using Probability Distributions: Reliability Evaluation of Series systems, Parallel systems – Partially redundant systems- determination of reliability measure- MTTF for series and parallel systems – Examples.

UNIT – IV

Discrete Markov Chains: Basic concepts- Stochastic transitional probability matrix- time dependent probability evaluation- Limiting State Probability evaluation- Absorbing states – Examples

Continuous Markov Processes: Modeling concepts- State space diagrams- Unreliability evaluation of single and two component repairable systems

UNIT – V

Frequency And Duration Techniques: Frequency and duration concepts, application to multi state problems, Frequency balance approach.

Approximate System Reliability Evaluation: Series systems – Parallel systems- Network reduction techniques- Cut set approach- Common mode failures modeling and evaluation techniques- Examples.

TEXT BOOKS

1. Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Plenum Press.
2. E.Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited

EE4534 **FLEXIBLE AC TRANSMISSION**

Externals: 60Marks **L-T-P-C**

Internals: 40Marks **4-0-0-3**

Course Objectives:

- To understand the concept of flexible AC transmission and the associated problems.
- To review the static devices for series and shunt control.
- To study the operation of controllers for enhancing the transmission capability.

Course Outcomes: Upon the completion of this course, the student will be able:

- To apply knowledge of FACTS Controllers.
- To design a Compensators within realistic constraints.
- To identify, formulate, and solve real network problems with FACTS controllers

UNIT I

INTRODUCTION : The concept of flexible AC transmission - reactive power control in electrical power transmission lines -uncompensated transmission line – series and shunt compensation. Overview of FACTS devices - Static Var Compensator (SVC) – Thyristor Switched Series capacitor (TCSC) – Unified Power Flow controller (UPFC) - Integrated Power Flow Controller (IPFC).

UNIT II
STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS
Voltage control by SVC – advantages of slope in dynamic characteristics – influence of SVC on
system voltage. Applications - enhancement of transient stability – steady state power transfer – enhancement of power system damping – prevention of voltage instability.

UNIT III
THYRISTOR CONTROLLED SERIES CAPACITOR(TCSC)AND APPLICATIONS
Operation of the TCSC - different modes of operation – modeling of TCSC – variable reactance
model – modeling for stability studies. Applications - improvement of the system stability limit –
enhancement of system damping – voltage collapse prevention.

UNIT IV

EMERGING FACTS CONTROLLERS: Static Synchronous Compensator (STATCOM) – operating principle – V-I characteristics Unified Power Flow Controller (UPFC) – Principle of operation - modes of operation –applications – modeling of UPFC for power flow studies.

UNIT V
CO-ORDINATION OF FACTS CONTROLLERS
FACTs Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

TEXT BOOK:

1. Hingorani ,L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000

2. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.

REFERENCES:

1. A.T.John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.
2. Narain G.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi 2001.