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MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

(A Govt. Aided UGC Autonomous Institute& NAAC Accredited Institute Affiliated to R.G.P.V., Bhopal MP)

Electrical Engineering Department

For batches admitted in Academic Session 2018-2019 & 2019-2020

Flexible
Scheme & Syllabus

2018-2022

&

2019-2023

B.Tech.

in

Electrical Engineering

Electrical Engineering Department

Madhav Institute of Technology & Science

Gwalior-474005

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

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Electrical Engineering Department

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100202: Energy, Ecology, Environment & Society (EEES)

L	T	Total Credits	End Sem	Mid Sem	Quiz/Assignment
03	-	03	70	20	10

Course Objectives: To create awareness about global energy status, climate issues and sustainable development for development of society using new rand renewable energy resources for power needs, to generate an understanding of human relationships, perceptions and policies towards environment and focus on design and technology for improving environmental quality and to develop moral values and morals to conduct efficiently and ethically in society.

Unit –I: Sources of energy: Renewable and non renewable energy, current Indian and global scenario of energy, state wise energy consumption, role of energy in economic and social development and social transformation. **Energy Polices:** National level and State level policy and International policy of G-8, G-20, OPEC and European countries, solar energy policy of India, National Solar mission energy policy issues. Energy securities and challenges in Indian context.

Unit 2: Energy conversion: Solar Energy, sun-earth angle, solar water heating, concentrated solar power, PV power: roof top; off Grid and on grid, Hydro, wind, biomass, geothermal, tidal and nuclear energy, Fossil fuels, thermal power station basic concepts. Per kilowatt hr cost of energy produced from various energy sources and its future prospects, business opportunities in various non conventional sources.

Unit –3: Ecology: Ecosystems, concept, components, types, Atmosphere, hydrosphere, lithosphere, biosphere, cycles in Ecosystem, Water, Carbon, Nitrogen. Biodiversity, threats and conservation, Producers, composers and decomposers, Energy and matter flow, Ecological succession, Food chains webs and ecological pyramids, Characteristics, structures and functions of ecosystems such as Forest, Grassland, Desert, Aquatic ecosystems. Community ecology- Characteristics, frequency, life forms, and biological spectrum, Ecosystem structure, Biotic and a-biotic factors, food chain, food web, ecological pyramids; Population ecology

Unit- 4:Environment: Air pollution, causes, classifications, adverse effects, Green house gases and effect, their major concerns, present status, emission from automobile, power, infrastructure, agriculture and transportation, environmental security. Global warming causes and effects, acid rain, ozone layer depletion, climate change, its model, impact on human health, national and international impact of climate change, Kyoto protocol, national and additional measures; flexible mechanism for reduction of carbon, clean development mission, joint implementation programme, carbon credit, carbon trading, emission trading, Voluntary Emission Rights (VER), Certified Emission Reductions (CER), and emission reduction unit (ERU). Indian initiatives of reduction in green house gases, Environmental ethics.

Unit -5: Values and ethics: Definition, Sources, and approaches to ethics, Social values and individual attitudes, Work ethics and work values, philosophical and Social ethics, human values and morals, business ethics, self concept and Johari Window, emotional intelligence, social intelligence, self development, character strengths and virtues, Impact of waste on society, management of e-waste.

Reference Books:

1. Cunninghan WP and MA; Principles of Environment Sciences; Tata McGraw Hill (TMH)
2. Pandey, S.N. & Mishra, S.P. Environment & Ecology, 2011,Ane Books,Pvt.Ltd,New Delhi
3. Svakumar; Energy Environment & Ethics in Society;TMH
4. Bukhootsow, B., Energy Policy and Planning, Prentice Hall of India, New Delhi, 2003.
5. Jose Goldenberg, Thomas Johanson, and Reddy, A.K.N., Energy for Sustainable World, WileyEastern, 2005.
6. Charles E. Brown, World Energy Resources, Springer Publication, New York, 2002.
7. Culp, A.W., Principles of Energy Conversion, McGraw Hill New York, 2004.
8. Bala Krishnamoorthy; "Environmental management";PHI
9. Gerard Kiely, "Environmental Engineering" ;TMH
10. Bharucha Erach, Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmadabad, 2002.

11. Chakraborty, S.K., Values and Ethics for Organizations, Theory and Practice, Oxford University Press, New Delhi, 2001.
12. Leary M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press. 2004
13. Louis P. P., "The Moral Life: An Introductory Reader in Ethics and Literature", Oxford Univ.Press. 2007

Course outcomes: After successfully completing this course the students will be able to

CO 1. Describe various energy resources, their conversion to electrical power and role in technological & economic development.

CO 2. Update with national/international power status and renewable power development targets & missions.

CO 3. Recognize the impact of pollution on the ecosystem and control policies adopted at national/international levels.

CO 4. Illustrate the concepts of ecosystems and their conservation.

CO 5. Solve practical problems of society in a sustainable and ethical manner.

CO 6. Fulfill professional duties keeping in mind the environmental safety, health, and welfare of public.

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Electrical Engineering Department

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100104: Basic Electrical & Electronics Engineering

L	T	P	Total Credits	End Sem	Mid Sem	Quiz/Assignment
03	-	2	04	70	20	10

COURSE OBJECTIVES:

- To impart the basic knowledge about the D.C circuits and its applications.
- To inculcate the understanding about the AC fundamentals.
- To convey the basic knowledge of magnetic circuits and its terminology.
- Highlight the importance of transformers in transmission and distribution of electric power.
- To understand the working of D C Machine.
- To know about various electronic circuits and its importance.

Unit I - D.C. Circuits Analysis:

Voltage and Current Sources: Dependent and independent source, Source conversion, Kirchhoff's Law, Mesh and Nodal analysis. Network theorems: Superposition theorem, Thevenin's theorem & Norton's theorem and their applications.

Unit II – Single-phase AC Circuits:

Generation of sinusoidal AC voltage, definitions: Average value, R.M.S. value, Form factor and Peak factor of AC quantity, Concept of Phasor, analysis of R-L, R-C, R-L-C Series and Parallel circuit, Power and importance of Power factor.

Unit III- Magnetic Circuits:

Basic definitions, AC excitation in magnetic circuits, self inductance and mutual inductance , Induced voltage, laws of electromagnetic Induction, direction of induced E.M.F. Flux ,MMF and their relation, analysis of magnetic circuits.

Unit IV- Single-phase Transformer & Rotating Electrical Machines:

Single phase transformer, Basic concepts, construction and working principal, Ideal Transformer and its phasor diagram at No Load, Voltage, current and impedance transformation, Equivalent circuits and its Phasor diagram, voltage regulation, losses and efficiency, testing of transformers, Construction & working principle of DC and AC machine.

Unit V - Digital Electronics, Devices & Circuits:

Number systems used in digital electronics, decimal, binary, octal, hexadecimal, their complements, operation and conversion, Demorgan's theorem, Logic gates- symbolic representation and their truth table. Introduction to semiconductors, Diodes, V-I characteristic, Bipolar junction transistors and their working, Introduction to CB, CE & CC transistor configurations

Text Book

1. Basic Electrical and Electronics Engineering, Tata McGraw Hill - D.P. Kothari & I.J. Nagrath

Reference Books:

2. Basic Electrical and Electronics Engineering, Tata McGraw Hill – V N Mittle & Arvind Mittal

3. Electrical Machinery- A.E. Fitzgerald, C. Kingsley and Umans - TMH
4. Principles of Electrical Engineering- Vincdent Del Toro- Prentice Hall.
5. Basic Electrical engineering -A,E. Fitzgerald, Higginbotham and Grabel -TMH
6. Integrated Electronics- Millmann & Halkias
7. Electronics Devices & circuits- Sanjeev Gupta, Dhanpat Rai Publication
8. Basic Electrical and Electronics Engineering, Tata McGraw Hill - D.C Kulshreshtha

COURSE OUTCOMES

After the completion of the course, the student will be able to –

CO 1. **Solve** DC & AC circuits by applying fundamental laws & theorems
CO 2. **Analyze** the response of linear electrical and magnetic circuits for given input
CO 3. **Explain** the working principle, construction, applications of rotating electrical machines
CO 4. **Explain** the working principle, constructional details, losses & applications of single phase transformer.
CO 5. **Select** the logic gates for various applications in digital electronic circuits.
CO 6. **Explain** characteristics of Diode and Transistor.

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Basic Electrical & Electronics Engineering Lab (100104)

LIST OF EXPERIMENT

1. Verification of Kirchhoff's Current Law & Kirchhoff's Voltage Law.
2. Verification of Superposition Theorem.
3. To determine resistance & inductance of a choke coil.
4. To determine active & reactive power in a single phase A.C circuit.
5. To determine voltage ratio & current ratio of a single phase transformer.
6. To determine the polarity of a single phase transformer.
7. To perform open circuit & short circuit test on a single phase transformer.
8. Measurement of various Electrical Quantities using multimeter.
9. Study of construction details of D.C machine.
10. To determine the volt –ampere characteristics of diode in forward bias & reverse bias condition.

Course Outcomes:

After the completion of the lab, the student will be able to -

CO 1. **Verify** circuit theorems.

CO 2. **Perform** tests on transformer for determination of losses, efficiency & polarity.

CO 3. **Demonstrate** the constructional features of electrical machines

CO 4. **Acquire** teamwork skills for working effectively in groups

CO 5. **Prepare** an organized technical report on experiments conducted in the laboratory.

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Syllabi Third Semester & Fourth Semester (B.Tech.)

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Electrical Engineering Department

Scheme of Examination

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Electromagnetic Field Theory: 130301

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
03	1	-	04	70	20	10

Course Objectives:

- To provide the knowledge of electromagnetic fields and its use in understanding the working principles of various power apparatus and machines.
- To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles etc.
- To provide the basic concepts of vectors and fields, electrostatics, electric current flow, magnetic fields, Maxwell's equations, electromagnetic wave propagation.

Unit I Electrostatics – I:

Sources and effects of electromagnetic fields – Coordinate Systems –Vector fields –Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity –Field due to discrete and continuous charges – Gauss 's law and applications.

Unit II Electrostatics – II:

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization- Dielectric strength- Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

Unit III Magnetostatics:

Lorentz force, magnetic field intensity (H) – Biot Savart's Law -Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.'

Unit IV Electrodynamic Fields

Magnetic Circuits - Faraday's law – Transformer and motional EMF –Displacement current Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

Unit V Electromagnetic Waves

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth – Pointing vector – Plane wave reflection and refraction – Standing Wave –Applications.

Recommended Books:

1. Elements of Electromagnetic by Mathew N.O Sadiku, Oxford.
2. Electromagnetic Fields by P.V. Gupta, Dhanpat Rai.
3. Element of Engineering Electromagnetic by N.N. Rao, PHI.
4. Engineering Electromagnetic by William H. Hayt; TMH.
5. Electromagnetic by John D. Kraus, TMH.
6. Electromagnetic wave & Radiating System by Jordan Balmian, PHI.
7. Fields and Wave Electromagnetic by David K. Cheng, Addison Wesley.
8. Electromagnetic Field by S.P. Seth, Dhanpat Rai & Sons

Course Outcomes:

CO 1. **Interpret** Maxwell's equations in differential and integral forms, both in time and frequency domains.

CO 2. **Define** complex permittivity, permeability, conductivity and perfect electric and perfect magnetic conductors.

CO 3. **Derive** Poyntings theorem from Maxwells equations and interpret the terms in the theorem physically.

CO 4. **Apply** vector calculus to understand the behavior of static electric fields in standard configurations

CO 5. **Formulate** engineering problems of Electromagnetic, Electrostatic and Magnetic to Static circuits using Basic relations

CO 6. **Solve** engineering problems of Electromagnetic.

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Measurement & Instrumentation: 130302

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
03	-	02	4	70	20	10	30	20

Course Objectives:

To develop an understanding of different instruments for measuring various electrical/ electronic parameters, their suitability, and the importance of their accuracy and need for calibration.

Unit I Basic Measurement Concepts:

Static and dynamic characteristics, units and standards of measurements, error analysis, Statistical evaluation of measurement data, Standards and calibration, Principle and types of analog voltmeters and ammeters. Single and three phase wattmeters and energy meters, Cathode ray oscilloscopes- block schematic, applications and special oscilloscope.

Unit II Measurement of Resistance:

Measurement of Resistance: low resistance, medium resistance and high resistance by Voltmeter, Ammeter, Kelvin's Double Bridge, Wheatstone bridge method, Direct Deflection method Loss of charge method and Ohmmeter. Measurement of Earth Resistance.

Unit III Measurement of Inductance, capacitance and frequency by A.C. Bridges:

Measurement of Self Inductance: Maxwell inductance bridge, Maxwell inductance-capacitance bridge, Hay's bridge, Anderson bridge and Owen's bridge.
Measurement of capacitance: De Sauty's bridge and Schering bridge, High voltage Schering bridge, Measurement of Relative Permittivity with Schering bridge
Measurement of Mutual Inductance: Heaviside mutual inductance bridge Cambell's modification of Heaviside Bridge.
Measurement of Frequency: Wien's Bridge.

Unit IV Instrument Transformers:

Instrument Transformer, ratio & Phase angle error, Design consideration construction and characteristics, Effect of variation of PF, secondary burden & frequency, Precaution in using CT and PT, Magnetizing & Demagnetizing of Instrument transformers, Absolute method of testing of CT and PT, Phantom loading.

Unit V Data Acquisition Systems and Transducers:

Elements of data acquisition system, digital voltmeters, A/D, D/A converters, interfacing of transducers frequency counter, measurement of frequency and time interval digital counter, timer digital frequency counter. Wave analyzer, Distortion analyzer, Distortion meters and Spectrum analyzer.
Transducers: Basic concepts of transducers, Selection criteria for particular application & classification, Study of various types of transducers: Resistance, Inductance, Capacitance, Piezoelectric, Thermocouple, RTD, Photocell, optical and digital transducers.

Text and Reference Books:

1. A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai & Sons, 2004.
2. J.B. Gupta, "A Course in Electronics & Electrical Measurements & Instrumentation", S.K. Kataria & Sons, 2003.
3. Albert D.Helfrick and William D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2003.
4. Joseph J.Carr, "Elements of Electronics Instrumentation and Measurement", Pearson education, 2003.
5. Alan. S. Morris, "Principles of Measurements and Instrumentation", Prentice Hall of India, 2nd edn., 2003.
6. Ernest O. Doebelin, "Measurement Systems- Application and Design", Tata McGraw-Hill-2004.
7. Modern Electronic Instrumentation & Measurement Techniques-A.D. Helfrick & W.D.Cooper, Prentice Hall
8. Electrical Measurement & Measuring Instruments by E.W. Golding , PHI.

Course Outcomes:

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

CO 1. Explain the basic concepts of electrical and electronic measurement and measuring instruments.
CO 2. Determine errors in a measurement system.
CO 3. Describe the construction and working of AC and DC bridges and their applications
CO 4. Select suitable measuring instrument, signal Generator, frequency counter, CRO and digital IC tester for appropriate measurement
CO 5. Select appropriate passive, active transducers and A/D & D/A converters for measurement of physical quantity.
CO 6. Describe working principle of CT & PT and their applications

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Scheme of Examination

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Measurement & Instrumentation Lab: 130302

List of Experiments:

1. Study of different types of multimeters and measurements of various electrical quantities using them.
2. Handling of CRO and function generator & measurements of frequency and voltage of different types of signals.
3. Medium resistance measurements using Wheatstone's Bridge.
4. Measurement of Inductance using Hay's Bridge.
5. Measurement of capacitance using De-Sauty's Bridge.
6. Calibration and characteristics study of RTD and Thermister.
7. Calibration of single phase AC Energy meter by direct loading method.
8. Measurement of Frequency using Wein's Bridge.
9. Component testing using CRO.
10. Study of Owen's Bridge and measurement of unknown Inductance.

Course Outcomes:

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

CO 1. **Handle** an instrument and perform basic calibration

CO 2. **Estimate** the deviations in measurements due to possible errors and measures to minimize them based on their characteristics.

CO 3. **Measure** unknown resistance, inductance and capacitance

CO 4. **Acquire** teamwork skills for working effectively in groups

CO 5. **Prepare** technical report on experiments conducted in the lab.

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Network Analysis: 130303

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
03	-	02	4	70	20	10	30	20

Course Objectives:

To make the students capable of analyzing any given electrical network, the balanced and unbalanced three phase circuits, understand the graph theory for solving various electrical circuits, understand the concepts of transients and relate two port parameters.

Unit I

Overview of DC and AC Circuits: Kirchhoff's voltage and current laws, network theorems viz. Thevenin's, Norton's, Superposition, Maximum power Transfer, Reciprocity, Substitution, Compensation, Miliman's and Tellegen's Theorem.

Unit II

Coupled Circuit and Resonance: Magnetic coupling, mutual inductance and its sign convention, coefficient of mutual inductance, transformer as a coupled circuit, singly and doubly tuned circuit, critical coupling, series and parallel resonance, bandwidth selectivity and half power points, Analysis of series and parallel circuit.

Unit III

Two Port Network: The concept of complex frequency, Concept of Ports. Two port parameters e.g. z-parameter, y-parameters., ABCD and inverse ABCD parameters, h and g parameters and their determination, Ladder network, condition for reciprocity and Symmetry in two port parameter representation, Inter-relationships between parameters of two port network, Interconnections of two port networks.

Unit IV

Three Phase Circuit: Unbalanced 3 phase circuit, balanced and unbalanced star (with or without neutral) and delta connected load.

Introduction to Graph theory: Concept of Network graph, Tree, Tree branch & link, Incidence matrix, cut set and tie set matrix.

Unit V

Transient: Initial condition, Laplace analysis, Theorem shifting, scaling, initial and final value and convolution theorem. Transient response of RL, RC and RLC circuit, time constant, Equivalents of charged inductor and capacitor, discharge of condenser, damped and oscillatory circuit. Response of the network with impulse, Unit step and Ramp excitation, wave form synthesis, AC transients (RLC circuit response to sinusoidal voltage)

Recommended Books:

1. Network Analysis by ME Van Valkenburg , PHI Publication.
2. Circuit Analysis by A. Chakrawarti , Dhanpat Rai Publication.
3. Network Analysis and Synthesis by C.L. Wadhwa, New Age International Publication.
4. Network Analysis and Synthesis Pankaj Swarnkar, Tech India Publication.

Course Outcomes:

After the completion of this course students will be able to:

CO 1.	**Apply** different AC and DC networks laws & theorems for solving electric network.
CO 2.	**Analyze** the series/parallel resonant and magnetically coupled circuits
CO 3.	**Solve** three-phase circuits under balanced & unbalanced conditions
CO 4.	**Evaluate** transient response, Steady-state response, network functions
CO 5.	**Analyze** the circuit behavior with initial conditions
CO 6.	**Compute** the two-port parameters

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Network Analysis Lab: 130303

List of Experiments:

1. Verification of Milliman's theorem.
2. Verification of Maximum power transfer theorem.
3. Verification of Thevenin's theorem.
4. Verification of Superposition theorem.
5. Verification of Reciprocity theorem.
6. To verify the series resonance in RLC circuit.
7. Determination of cut off frequency of given low pass & high pass filter.
8. Determination of ABCD constants of two port network.
9. Determination of short circuit parameters (Y parameter) of two port network.
10. Determination of open circuit parameters (Z parameter) of two port network.

Course Outcomes:

On the successful completion of the lab experiments students will be able to:

CO 1. **Design** simple networks by exploring circuit theorems.

CO 2. **Analyze** transient behavior of RL, RC & RLC circuit using the appropriate instruments

CO 3. **Develop** teamwork skills for working effectively in groups

CO 4. **Prepare** technical report on experiments conducted in the lab.

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Analog Electronics: 130304

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
03	-	02	4	70	20	10	30	20

Course Objectives:

The course intends to provide an understanding of the principles, operation and application of the analog building blocks like diodes, BJT, FET etc. for performing various functions, use of simple models and equations to illustrate the concepts involved, an overview of different amplifiers and oscillators and the knowledge about practical analog circuits.

Unit I

Special Diodes: LED, Varactor diode, Photo diode, Schottky diode, Tunnel diode; their characteristics and applications. Rectifiers, Characteristics of diodes, BJT, MOSFET.

Unit II

Transistor Biasing: CE, CB and CC configuration, Input output characteristics, Operating point Transistor load line, Transistors as a switch. Frequency Response: Amplifier transfer function, low and high frequency response of common emitter and common base configuration.

Unit III

Transistors Amplifier: Small Signal BJT amplifiers: AC equivalent circuit, hybrid model and their use in amplifier design. Multistage amplifiers, frequency response of basic & compound configuration, Power amplifiers; Class A, B, AB, & C Amplifier.

Unit IV

Feedback & Oscillator Circuits: Effect of positive and negative feedbacks, basic feedback & their properties, Analysis of practical feedback amplifiers, Sinusodial Oscillators, Crystal Oscillators, tuned oscillators- Collpits and Hartley, Multivibrators, 555 timer.

Unit V

Operational Amplifiers: Op-Amp Basics, Op-amp parameters characteristics ideal and practical Op-Amp circuits, differential and Common mode operation, Inverting & Non Inverting operational Amplifier , Log and Antilog Op-Amp, Op-Amp applications.

Recommended Books:

1. Microelectronics Circuits by A.S. Sedra & K.C. Smith, Oxford University Press (1997)
2. Electronic Principles by A.P. Malvino, Tata Mcgraw Hill Publications
3. Electronic Devices & Circuit Theory by Robert L. Boylestad & Louis Nashelsky.

4. Digital Electronics by William Kleitz, Prentice Hall International Inc.
5. Introduction to Semiconductor Materials and Devices by M. S. Tyagi, , John Wiley & Sons Inc
6. Introduction to Electronic Devices Michael Shur by John Wiley & Sons Inc., 2000.

Course Outcomes:

After the completion of this course students will be able to:

CO 1. Explain working principles of electronic devices e.g. Diode, Zener Diode, LED, Rectifiers, Transistor, Power Amplifier, Oscillator and Op-Amp.

CO 2. Categorize the different types of Diode, Power Amplifier, Oscillators and Op-Amp and transistor Biasing.

CO 3. Explain the different types of characteristic of Diode, Transistor, Power Amplifier and Op-amp.

CO 4. Describe the various mathematical model of transistor e.g. Hybrid model, re model.

CO 5. Develop an ability and skill to design different types of diode rectifier, transistor biasing, oscillators and timer circuit.

CO 6. Apply the various principles of electronics to design different types of Analog Electronics circuits for various applications.

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Analog Electronics Lab: 130304

List of Experiments:

1. To observe the characteristics of diode in forward and reverse biased condition.
2. To construct the half wave rectifier using semiconductor diode and to find its performance curve.
3. To construct the half wave rectifier using semiconductor diode and to find its performance curve.
4. To determine the (i) Input characteristics and (ii) Output characteristics of the given transistor in common emitter configuration.
5. To verify the operation of Darlington Pair.
6. To Construct Wien bridge oscillator using 741 Op- amp and to measure the frequency of oscillation.
7. To analyze the operation of differential Amplifier using Transistor.
8. To observe and verify the amplification and voltage gain of a two stage RC coupled Amplifier.
9. To verify the operation of push pull Amplifier.
10. To observe the characteristics of SCR.

Course Outcomes:

On the successful completion of the lab experiments students will be able to:

CO 1. Develop the understanding of diode biasing conditions.

CO 2. Investigate the operation of half-wave and full wave rectifier and find their performance curves.

CO 3. Examine transistor configurations and investigate common emitter configuration input-output characteristics.

CO 4. Develop teamwork skills for working effectively in groups

CO 5. Prepare technical report on experiments conducted in the lab

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Software Lab-I: 130305

L	T	P	Total Credits	Practical End Sem	Lab Work & Sessional
-	-	02	1	30	20

List of Experiments:

1. To draw the V and I curve for RL Circuit using Matlab code.
2. To draw the V and I curve with varying time constant for RL Circuit using Matlab code.
3. To draw the V and I curve for RL Circuit using Matlab Simulink.
4. To draw the V and I curve for RC Circuit using Matlab code
5. To draw the V and I curve with varying time constant for RC Circuit using Matlab code.
6. To draw the V and I curve for RC Circuit using Matlab Simulink.
7. To Analyze the performance of series & parallel RLC circuit using MATLAB code
8. To Analyze the performance of series & parallel RLC circuit using MATLAB Simulink
9. To model second order differential equation using Matlab Simulink
10. To model third order differential equation using Matlab Simulink

Course Outcomes:

After the completion of this course students will be able to:

CO 1. Design Series & Parallel RL,RC, RLC circuit

CO 2. Simulate the performance of second order systems using MATLAB Simulink environment

CO 3. Validate the theoretical concepts by writing MATLAB codes.

CO 4. Design engineering problem in MATLAB environment

CO 5. Develop teamwork skills for working effectively in groups

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For batches admitted in Academic Session 2018-2019 & 2019-2020

Digital Electronics & Microprocessor: 130401

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
02	01	02	4	70	20	10	30	20

Course Objectives:

- To introduce the concepts and techniques associated with the number systems and codes, basic idea about microprocessor and its programming.
- To minimize the logical expressions using Boolean postulates and to apply the techniques and mathematics used in microprocessors for various control applications.
- To design various combinational and sequential circuits.

Unit- I

Number System and Binary Codes: Various number systems-decimal, Binary, Hexadecimal and Octal with mutual conversion, binary arithmetic in computers, addition, subtraction, multiplication and division, subtraction using 1's and 2's compliment, Excess 3, Gray code.

Unit- II

Minimization of Logic Function: AND, OR, NOT, NAND, NOR, EXOR, operations and gates, laws of Boolean algebra, deduction of Boolean expression, logic diagram, universal building blocks, negative logic, Minterms and Maxterms, Truth table and Karnaugh mapping, reduction of Boolean expression with SOP, POS and mixed terms.

Unit- III

Logic Hardware: Diode as switch, Bipolar transistor as switch, FET as switch, logic families (RTL, DTL, TTL, ECL, HTL, TSL, CMOS & Schottky logic).

Unit- IV

Combinational Logic Circuits: Encoders, Decoders, Multiplexers, Demultiplexer, Code Convectors, Parity Checker Generator, Arithmetic Circuit like Adder etc. Sequential circuits: State tables and diagrams, Flip Flop and its various types – JK, RS, T,D pulse and edge triggered flip flops transition and excitation tables, timing diagrams, Shift Registers, Series and Parallel Data Transfer, Ripple Counters, Synchronous Counters, Modulo N counter design, Up Down Counters Ring counter. Types and characteristics of semi conductor memories, static and dynamics memory.

Unit- V

Intel 8085 Microprocessor: Introduction to 8-bit 8085 microprocessor, Architecture of 8085 microprocessor, Pin Configuration, instruction set and Addressing modes, General application program.

Recommended Books:

1. Digital Systems by Tocci, Tata Mograw Hills Publishing company
2. Digital Computer and Electronics by Malvino, brown, TMH Publishing company
3. Digital Design by Morris Mano, Pearson Education
4. Digital computer Fundamentals by T.C. Bratee, 6th Edn. McGraw Hill.
5. An Introduction to Digital Computer Design by V. Rajaraman, and Radhakrishman, 3rd Edn. PHI.
6. Digital Principles and Applications by A.P. Malvino and B.P. Leach 4th Edn McGraw Hill.
7. Microprocessor & Interfacing by D.V. Hall, McGraw Hill International Edition.
8. Microprocessor Architecture, Programming and Applications by Gaonkar, Wiley Eastern Ltd.
9. Introduction to Microprocessors by A.P. Mathur, McGraw Hill International Edition.

Course Outcomes:

After the completion of this course students will be able to:

- **CO 1.** **Explain** the concept of different Number systems, logic family and Microprocessor.
- **CO 2.** **Design** the logic expressions using logic gates after simplifying the expression using Boolean laws and K-map method.
- **CO 3.** **Design** different types of logic circuits such as combinational circuits, sequential circuits.
- **CO 4.** **Describe** the working of logic families such (RTL, DTL, TTL, ECL, HTL, TSL,
  C-MOS & Schottky logic).
- **CO 5.** **Describe** an 8 bit microprocessor architecture & explain the concepts of memory and I/O interfacing with microprocessor

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Electrical Engineering Department

Scheme of Examination

For batches admitted in Academic Session 2018-2019 & 2019-2020

Digital Electronics & Microprocessor Lab: 130401

List of Experiments:

1. Verification of truth tables of
   (a) OR, AND, NOT gates (By using 7400-series)
   (b) NAND & NOR gates.
   (c) EX-NOR & EX-OR gates.
2. Verification of De-Morgan's Theorem using ICs.
3. Implementations of Multiplexer & Demultiplexer using logic gates (ICs) and verify truth table.
4. Implementations of Encoder & Decoder using logic gates (ICs) and verify truth table.
5. Implementations of Half Adder & Full Adder using logic gates (ICs) and verify truth table.
6. Implementations of Half Subtractor & Full Subtractor using logic gates (ICs) and verify truth table.
7. Implementation of Binary to Gray Code & Excess- 3 to BCD Converter using logic gates.
8. Operation and verifying truth tables of flip- flops- RS, D, and JK using ICs.
9. To perform addition & subtraction of two 8 bit numbers using 8085.
10. To perform the multiplication & division of two 8 bit numbers using 8085.

Course Outcomes:

On completion of this lab course the students will be able to:

CO 1. Develop skill to build, and troubleshoot digital circuits.

CO 2.Correctly operate standard electronic test equipment such as oscilloscopes, signal analyzers, digital multi-meters, power supplies, frequency meters, and programmable memories programmers to analyze, test, and implement digital circuits.

CO 3. Apply troubleshooting techniques to test digital circuits.

CO 4. Prepare and present an organized written engineering report on electronic testing of digital circuits.

CO 5. Develop the ability to work is team and learns professional ethics.

CO 6. Identify the importance for verification & testing of digital circuits.

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Electrical Machines-I: 130402

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
02	01	02	4	70	20	10	30	20

Course Objectives:

To develop basic concepts of AC and DC machines, their constructional details and working principles and to understand the practical applications and operational issues of transformer, induction motor and DC machines.

Unit- I

Basic Concepts of Rotating Electrical Machines: Physical concepts of torque production. Electromagnetic and reluctance torque, Constructional features of rotating machines i.e. DC machine. Induction machine and synchronous machine.EMF generation in dc and ac machines, MMF production on a distributed winding, Production of rotating magnetic field. AC & DC windings short pitching and distribution of winding. Fractional slot winding. Winding factors & harmonic elimination, Ratings and loss dissipation.

Unit- II

D.C. Machines I: Construction of DC Machines, Armature winding, EMF and torque equations, Armature reaction, Commutation, Interpoles and compensating windings, Performance characteristics of DC generators.

Unit- III

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

Unit- IV

Single Phase Transformer: Phasor diagram, Efficiency and voltage regulation, All day efficiency, Testing of Transformers- O.C. and S.C. tests, Sumpner's test, and Polarity test. Auto Transformer- Single phase and three phase auto transformers, Volt-amp relation, Efficiency, Merits & demerits and applications.

Unit- V

Three Phase Induction Motor I: Review of constructional details. Principle of operation, Slip. Production of torque, Steady state analysis. Phasor diagram, equivalent circuit. Power flow diagram and Torque speed characteristics. Starting methods

Recommended Books:

1. Electric Machines by D.P. Kothari & I.J. Nagrath, Tata McGraw Hill
2. Electric Machines by Ashfaq Hussain, Dhanpat Rai & Company
3. Electric Machinery by A.E Fitzerald, Kingsley and S.D. Umans, McGraw Hill.
4. Electrical Machinery by P.S. Bimbhra, Khanna Publisher
5. Generalized Theory of Electrical Machines by P.S. Bimbhra, Khanna Publishers
6. Alternating Current Machines by M.G.Say, Pitman & Sons

Course Outcomes:

After completing this course the student will be able to:

CO 1. **Explain** the principles and construction of different AC and DC machines.
CO 2. **Discuss** the fundamental control practices such as starting, reversing, braking, plugging etc. associated with AC and DC machines.
CO 3. **Analyze** the performance of AC and DC machines.
CO 4. **Develop** the equivalent circuits and compute the induced emf, torque, efficiency, losses etc.
CO 5. **Describe** various tests conducted for evaluating the performance of AC and DC machines.
CO 6. **Evaluate** the performance of machines under different operating conditions.

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Electrical Machines-I Lab: 130402

List of Experiments:

1. To perform parallel operation of single phase transformer.
2. To determine the efficiency of a Single Phase Transformer by direct loading.
3. To perform Scott connection for conversion of 3 phase into 2 phase and vice-versa.
4. To determine the external characteristics of DC Compound generator.
5. To control the speed of DC shunt motor by armature resistance and field control resistance.
6. Methods of starting of three phase induction motor.
7. To perform No Load and Block Rotor test on three phase induction motor.
8. To determine the speed torque characteristics of three phase induction motor.
9. To determine the efficiency of three phase induction motor.
10. To perform the Hopkinson's test on DC Compound motor.

Course Outcomes:

At the end of the Laboratory work the students will be able to

CO 1. **Estimate** which apparatus at what rating is required for a particular experiment.

CO 2. **Draw** characteristics of electric machine for a specific purpose requirement.

CO 3. **Determine** the efficiency of any transformer, regulation of any transformer.

CO 4. **Conduct** Load sharing by two or more machines

CO 5. **Develop** the ability to work in team and learns professional ethics

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Control System: 130403

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment
03	01	-	4	70	20	10

Course Objective:

- To study the fundamental concepts of control system problems and their solution possibilities,
- To study the mathematical modeling of the various physical systems,
- To understand the concept of time-domain response (transient and steady-state response) and frequency-domain analysis of the systems,
- To learn the basics of stability analysis of the systems, specifications of controller and compensator design and its implementations.

Unit-I

Modeling of Physical Systems: Translational & Rotational Transfer Function of Electrical and Mechanical systems. Feedback characteristics of control systems, Open loop and closed loop systems, effect of feedback sensitivity to parameter variations, Block diagram representation and reduction techniques, Signal flow graphs, Mason's rule. Control systems and its components, error sensing devices: Potentiometers, Tacho generators and Synchros, A.C. & D.C. servomotor.

Unit-II

Time Response Analysis: Transient Response Analysis: Transient and steady-state response analysis for first and second order systems and their qualitative analysis; error analysis and error constants., Derivative and Integral error compensation, P, PI, PD, PID Controller.

Unit-III

Frequency Response Analysis: Frequency domain specifications of second order system, Polar plot, Bode plots, M Circles, N Circles. Compensator Design: Lead, lag and lag-lead compensation using frequency response methods.

Unit-IV

State Variable Analysis: Concept of state, state variables and state models, state equations and state transition matrix, relationship between transfer function and state equations, control system with state variable feedback, controllability & observability.

Unit-V

Stability: Stability, Absolute and relative stability, Routh Hurwitz stability criteria, Root Locus Analysis: Development of root loci, effects of pole/zero on loci, Nyquist plot & Nyquist stability criterion

Text Books:

1. Control System Engineering by I.J. Nagrath and M. Gopal, New Age International Publication.
2. Control Systems by U. A. Bakkshi, Technical Publication, Pune.
3. Linear Control Systems by B. S. Manke, Khanna Publishers
4. Automatic Control System by S.C. Gupta, New Age International Publication.

Reference Books:

1. Control System Engineering by Norman Wiley Publication.
2. Automatic Control System by B.C. Kuo, Oxford University Press & Pearson Education.
3. Modern Control Engineering by K. Ogata, Pearson Education, Asia.

Course Outcomes

After the completion of this course students will be able to:

CO 1.	**Develop** mathematical models of mechanical system, electrical system and electromechanical system
CO 2.	**Represent** the complex system into standard canonical form by signal flow graph and block diagrams reduction rules
CO 3.	**Compute** the time and frequency-domain responses of first and second-order systems to standard inputs.
CO 4.	**Formulate** control engineering problems in state-variable form
CO 5.	**Evaluate** the stability of a closed-loop control system in time-domain as well as in frequency-domain
CO 6.	**Predict** the nature of response for the given input

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Power System -I: 130404

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
03	01	-	04	70	20	10

Course objectives

- To Familiarize the students with conventional and Non-Conventional energy sources and their use in electrical power generation.
- To expose the students with Transmission and distribution system, line parameters, performance of transmission lines, power plant economics and different types of tariffs.

Unit 1:

Energy Resources and Electrical Power Generation: Introduction to Conventional and non-conventional energy resources; Availability of resources; National and International energy trends; Global warming and greenhouse effects. Generation of electrical power, Conventional power generation - Hydro, Thermal, Nuclear and Gas Power; Renewable energy generation.

Unit 2:

Transmission and Distribution Systems: Introduction, electrical supply system, comparison of AC and DC systems, overhead versus underground systems, choice of working voltages for transmission and distribution, transmission and distribution system architecture. Overhead line insulators, types of insulators pin, suspension and strain insulators, insulator materials, insulator string; Calculation of voltage distribution and string efficiency, methods of equalizing voltages, use of guard rings. Corona.

Unit 3:

Line Parameters: Types of conductor, Inductance of a conductor due to internal flux, Inductance of a single phase & three phase transmission line, Self & mutual G.M.D., Inductance of three phase symmetrical and unsymmetrical spaced lines, transposed lines. Bundle conductors, skin effect, capacitance of single & three phase transmission line, effect of earth and charging current, transmission line communication and line interference.

Unit 4:

Performance of Overhead Transmission Line: Single line diagram of power system, ABCD constant and equivalent circuits of short, medium and long transmission line, regulation and efficiency of short, medium, transmission line, Ferranti effect, surge impedance loading. Long transmission line, Generalized circuit equation relation between generalized circuit constant for simple network

Unit-5

Power plants Economics and Tariff: Size and number of generating units. Effect of load factor on cost of generation, Load curves, Maximum demand, Load factor, diversity factor, Plant capacity and plant use factor, type of tariffs and economics of power factor improvements.

Recommended Books:

1. Electric Power Generation, Transmission and Distribution by S.N. Singh, Prentice Hall of India, 2nd Edition.
2. Power system Analysis by A. Husain A, CBS Pub & Distributor.
3. Power System Analysis by B.R. Gupta B.R, S Chand & Co.
4. Electrical Power by S.L. Uppal, Khanna Publishers Limited, New Delhi
5. Electrical Power Systems by C.L. Wadhwa, New Age International Publishers Ltd., New Delhi

Course Outcomes

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

CO1 **Describe** the general structure of power systems

CO2 **Develop** the knowledge of generation of electricity based on conventional and nonconventional energy sources

CO3 **Determine** the transmission line parameters

CO4 **Analyze** the performance of overhead transmission line

CO5 **Describe** the concept of power plant economics

CO6 **Explain** different types of tariffs and power factor economics

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Software Lab-II: 130405

L	T	P	Total Credits	Practical End Sem	Lab Work & Sessional
-	-	04	2	30	20

List of Experiments:

1. To model a DC motor and draw speed torque characteristics.
2. Model and calculate efficiency and voltage regulation for a single phase transformer.
3. Determination of step & impulse response for a type '0', type '1', type '2' systems.
4. Determination of Root Locus plot and Nyquist Plot using MATLAB control system toolbox.
5. Study the effect of PI & PD controller on system performance.
6. Calculation of eigen value and eigen vector using MATLAB.
7. Write the code for the logic gates.
8. Implementation of boolean expression using MATLAB simulink.
9. Implement R-S and J-K flip flop using MATLAB.
10. Calculation of A, B, C, D parameters of transmission lines.

Course Outcomes:

After the completion of this course students will be able to:

CO 1. **Simulate** the performance of DC motor using MATLAB Simulink environment.

CO 2. **Validate** the concepts of Induction motor by writing MATLAB codes.

CO 3. **Analyze** the waveforms on parameter variation of PV Array module using MATLAB Environment.

CO 4. **Compare** the performance of renewable energy sources using MATLAB environment.

CO 5. **Design** engineering problem and validate the results using MATLAB environment.

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Syllabi Fifth Semester & Sixth Semester (B.Tech.)

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Signals & Systems: 130501

L	T	P	Total Credits	End Sem	Mid Sem	Quiz/Assignment
03	01	-	04	70	20	10

Course Objectives:

To develop an understanding of fundamental characteristics of signals and systems in both time and transform domains and to develop mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Unit I

Dynamic Representation of Systems: Definition & Classification of signals, Systems Attributes, Causality linearity, Stability, time invariance. Special Signals, Complex exponentials, Singularity functions (impulse and step functions). Linear Time-Invariant Systems: Differential equation representation convolution Integral. Discrete form of special functions. Discrete convolution and its properties, Realization of LTI system (differential and difference equations).

Unit II

Fourier Analysis of Continuous Time Signals and Systems: Fourier Series, Fourier Transform and properties, Parseval's theorem, Frequency response of LTI systems, Sampling Theorem.

Unit III

Fourier Analysis of Discrete Time Signals & Systems: Discrete-Time Fourier series, Discrete-Time Fourier Transform (including DFT) and properties, Frequency response of discrete time LTI systems.

Unit IV

Laplace Transform: Laplace Transform and its inverse: Definition, existence conditions, Region of Convergence and properties, Application of Laplace transform for the analysis of continuous time LTI system (stability etc.) Significance of poles & zeros.

Z-Transform : Z-Transform and its inverse: Definition, existence, Region of convergence and properties, Application of Z-Transform for the analysis of Discrete time LTI Systems, Significance of poles and zeros.

Unit V

Sampling: The sampling theorem, reconstruction of signal from its samples, sampling in the frequency domain, sampling of discrete-time signals.

Recommended Books:

1. Signal and systems by Oppenheim AV, Willisky AS and Nawab SH, Pearson
2. Signals and systems by Hwei. P. Hsu, Schaum's outlines, TME
3. Digital Signal Processing Principles by Proakis JP, Manolaxis, Pearson
4. Fundamentals of Signals & Systems by Michael J Roberts, McGraw Hill

Course Outcomes

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

CO 1. **Explain** the process of sampling and the effects of under sampling.

CO 2. **Classify** systems based on their properties and determine the response of LSI system using convolution.

CO 3. **Apply** the concepts of linear algebra to signals.

CO 4. **Analyse** the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.

CO 5. **Analyze** system properties based on impulse response and Fourier analysis.

CO 6. **Apply** the Laplace transform and Z- transform for analysis of continuous-time and discrete-time signals and systems.

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Power System-II: 130502

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
02	01	02	04	70	20	10	30	20

Course Objectives:

- To expose the students to the concepts of Load Flow Studies, Symmetrical and Unsymmetrical Faults, Power System Stability, Power System Control, Underground Cables and HVDC Transmission System.
- To enable the students to solve problems related to Load Flow Studies, Fault analysis, Power System Stability, Power System Control and Underground Cables.

Unit I.

System Representation and Load Flow Analysis: Single line representation, Per unit system, Network Model formulation, Formulation of YBUS, Formation of static load flow equations, solution of load flow problem by Gauss-Seidel, Newton-Raphson (polar and rectangular) and fast decoupled load flow methods.

Unit II.

Symmetrical and unsymmetrical fault: Review of symmetrical components, sequence networks, symmetrical fault analysis, unsymmetrical fault analysis, analysis of open conductor fault, fault calculations for symmetrical and unsymmetrical faults.

Unit III.

Power System Stability: Basic concepts of steady state, dynamic and transient stability, power angle equation, synchronizing power coefficient, equal area criterion, critical clearing angle, Swing equation, multi-machine transient stability studies with classical machine representation, factor affecting stability and methods of its improvement.

Unit IV.

Power System Control: Elementary idea of load-frequency control, automatic generation control, reactive power and voltage control. Series and shunt compensation techniques, Tap changing transformers, phase shifting transformers, Induction regulator, Economic limit of VAR control.

Unit V.

Underground Cables and HVDC Transmission : Types of cables, Insulation resistance of cable, Electrostatic stress and grading of cables, rating and power factor of cables, Brief history of DC transmission, comparison of HVDC with EHV AC transmission systems, Basic converter circuit used in HVDC system, types of HVDC links.

Recommended Books:

1. Advanced Power System Analysis and Dynamics, L.P. Singh, Wiley Eastern Ltd, 6th ed. 2017.
2. Modern Power System Analysis, Nagrath & Kothari, TMH Publishers, 4th ed. 2016.
3. Elements of Power System Analysis, W.D. Stevenson, McGraw-Hill, 4th ed. 2017.
4. Power system operation and control, A.J. Wood &Woollenberg, 2nd ed. 2010.
5. HVDC Power Transmission Systems: Technology and System Interactions, K. R. Padiyar, New Age International, 3rd ed. 2017.

Course Outcomes

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

CO 1. **Explain** the concepts of single line diagram and per unit system

CO 2. **Apply** different load flow techniques to solve load flow problem

CO 3. **Perform** fault calculations for symmetrical and unsymmetrical faults

CO 4. **Explain** the theoretical and practical aspects of Power System Stability and its enhancement

CO 5. **Elucidate** the automatic generation control reactive power, voltage control, series and shunt compensation

CO 6. **Discuss** the insulation resistance, capacitance of various types of cables and the need of HVDC transmission.

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Power System-II Lab: 130502

S. No.	Name of the Experiment
1	Demonstration of EHV AC Transmission line simulation panel
2	Measurement of resistance, inductance and capacitance of EHV AC Transmission line simulation panel
3	Study of Cables, Insulators and line supports used in transmission and distribution system
4	Calculation of generalized circuit constants for short, Medium and Long transmission line
5	Simulation of L-G, L-L, L-L-G, L-L-L, L-L-L-G faults using MATLAB
6	Development of MATLAB code to determine the maximum power without loss of synchronism using equal area criterion
7	Development of MATLAB code to determine the critical clearing angle and critical fault clearing time
8	To determine the system stability from the swing curve
9	Use MATLAB rlocus function to obtain the root locus plot
10	A visit and study of 33kV Substation

At the end of the Laboratory work the students will be able to

CO 1. Demonstrate the performance EHVAC transmission line.
CO 2. Determine transmission line parameters.
CO 3. Simulate the different types of faults in transmission line using MATLAB.
CO 4. Identify the different components of substation & their applications
CO 5. Familiar with construction & application of various insulator, cables & line support.
CO 6. Prepare report for presentation.

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ELECTRICAL MACHINES-II: 130503

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
02	01	02	04	70	20	10	30	20

Course Objective: To develop basic concepts about AC machines, their constructional details and working principles and to understand the practical applications and operational issues of three phase transformer and other rotating machines

UNIT-I

Transformer: Three phase transformers, Special construction features, Single phase Transformers connected as 3 phase bank. Phasor diagram of star/star, Star/delta, Delta/delta, Delta/star, connected 3 phase transformers and their uses. Phase conversion. Three to two phase open delta or V connection, Parallel operation of single phase and three phase Transformers, load sharing, harmonics in transformer, Magnetization current wave form, Tertiary winding.

UNIT-II

Three phase Induction Motor II: Circle diagram and its experimental determination. cogging and Crawling Losses, Efficiency and Testing I.M, Double cage induction motor. Operation on unbalanced voltages, Speed control. Rotor resistance control. pole changing method. Frequency control. Induction generator.

UNIT-III

Synchronous machine I: Constructional features.salient pole and cylindrical synchronous machines. Relation between speed, Frequency and no. of poles, excitation.Voltage generation. Generator mode.Interaction between excitation flux and armature EMF.Voltage regulation, phasor diagram on load. Leakage reactance and synchronous reactance. Steady state parameters of synchronous machines, open circuits, Short circuit and zero power factor tests. Determination of voltage regulation by synchronous impedance method. MMF method and potier triangle method

UNIT-IV

Synchronous machine II: Two reaction theory .Slip test .Expression for power developed and power angle curves. Synchronization of alternators Dark and bright lamp method .Synchro scope Parallel operation and load string. Effect of governor charectristics on load sharing.operation on infinite bus bar.

UNIT-V

Synchronous machine III: Motoring mode, transition from motoring to generating mode. V curves starting. Synchronous condenser. Hunting, damper winding synchronizing torque and power analysis under sudden short circuit. Transient parameters of synchronous machines. Various transient and sub transient reactance. Time constant, Expression of transient and sub transient reactance Analysis of3 phase short circuit oscillogram and determination of transient parameters from oscillogram . Short circuit ratio.

Text and Reference Books:

1. Theory of Alternating current Machinery by Alexender S Langsdorf.
2. The performance and design of AC machines by M.G. Say ,CBS Publication.
3. Electric machine by Nagrath and Khotari. TMH.
4. Geneathized theory of electrical machine by P.S. Bimbhra, Khanna publication
5. Electrical machines by P.S. Bimbhra, Khanna publication
6. The Performance and Design of AC Commutator Machines by Openshaw Taylor. CBS Publication

Course Outcomes:

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

CO 1. **Analyze** the performance of 3-phase induction and synchronous machines using equivalent circuits & phasor diagrams under different loading conditions.

CO 2. **Explain** the constructional details and working principle of three phase transformer and synchronous machine.

CO 3. **Develop** phasor diagram and determine voltage regulation of an alternator and its steady state performance.

CO 4. **Determine** time constant, various sequence reactance and equivalent circuit parameters under transient conditions for synchronous machines.

CO 5. **Analyze** the behavior of synchronous machine connected to infinite bus and parallel operation of alternators.

CO 6. **Analyze** the performance of 3-phase induction and synchronous machines using equivalent circuits & phasor diagrams under different loading conditions.

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Electrical Machines-II Lab: 130503

S. No.	Name of the Experiment
1	To Conduct No Load & Blocked Rotor Test on 3-Phase Sq. Cage Induction Motor and plot performance curve
2	To Conduct Load Test on 3-Phase Sq. Cage Induction Motor and plot performance curve
3	To Conduct No Load & Blocked Rotor Test on 3-Phase Slip Ring Induction Motor and plot performance curve
4	To Conduct Load Test on 3-Phase Slip Ring Induction Motor and plot performance curves
5	To Study the cascaded connection of Two 3-Phase Slip Ring induction motor
6	To Find out OCC and SCC of an Alternator and its regulation using synchronous impedance method
7	To find regulation of Alternator using ZPF Method
8	To draw V Curves of Synchronous motor
9	Synchronization of Alternators
10	a) Determination of X_d and X_q of an alternator using Slip Test b) Determination of X_d" and X_q" of an alternator (Positive sequence Reactance)

At the end of the Laboratory work the students will be able to

CO 1. Analyze the working of any electrical machine using mathematical model under loaded and unloaded conditions.

CO 2. Explain the working principle and different types of connections of three phase transformer.

CO 3. Derive the relation between real and reactive power control with application to the equivalent circuit of a synchronous machine.

CO 4. Demonstrate an understanding of the fundamental control practices associated with AC machines (starting, reversing, braking, plugging, etc.).

CO 5.Use accepted national and international standards (such as NEMA, IE Code) to select appropriate electrical machines to meet specified performance requirements.

CO 6.Conduct testing and experimental procedures on different types of electrical machines.

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Electrical Engineering Department

Scheme of Examination

For batches admitted in Academic Session 2018-2019 & 2019-2020

Power Electronics: 130504

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/ Assignment	Practical End Sem	Lab Work & Sessional
02	01	02	04	70	20	10	30	20

Course objective: To introduce the students the basic theory of power semiconductor devices and passive components, their practical application in power electronics and to familiarize the operation principle of AC-DC, DC-DC, DC-AC conversion circuits and their applications. Also to provide the basis for further study of power electronics circuits and systems.

Unit I. Power Semiconductor Devices: Power diodes, Transistors, Power MOSFET, IGBT, Thyristor TRIAC and GTO, Static and dynamic characteristics. Two transistor equivalent model of SCR, Firing & Commutation circuits, protection of SCR, Series and parallel operation.

Unit II. Rectifiers: Principle of phase controlled converter operation, Single phase half wave, full wave and semi converters. Three phase half wave, full wave and semi converters, Effect of load and source inductance. Rectifiers Application

Unit III. AC regulators, Cyclo-converter **& Dual converter:** Principle of AC phase control, Single and three phase AC voltage controllers, Cyclo-converter: Single and three phase, dual converters.

Unit IV. Inverter circuits: Principle of operation, Single phase and three phase inverters. Voltage control using PWM technique, Current source inverters, single phase series & parallel inverter, Inverter applications.

Unit V. DC-DC converters**:** Principles of operation, Control strategies, Single & multi quadrant chopper. Steady state time domain analysis of step down chopper, Voltage commutated Chopper, and their application

Recommended Books:

1. Power Electronics by P.C. Sen, McGrawHill, 1st Ed., 2001
2. Power Electronics by P.S. Bimbhra, Khanna Publishers, 5th ed., 2012
3. Power Electronics: Circuits, Devices & Applications by MH Rashid, Pearson, 5th ed., 2012
4. Power Electronics by Cyril W.Lander , McGraw-Hill; 2nd edition,1987
5. Power Electronics Principles and Applications by JoshephVidyathil, TMH,2010

Course Outcomes:

After completing this course the student will be able to:

CO 1. Explain static & dynamic characteristics of power electronics devices like Diode SCR, BJT, MOSFET and IGBT, etc

CO 2. Explain the configuration of different commutation methods.

CO 3. Describe the configuration of AC to DC converter, Dual converter, chopper, cyclo-converter.

CO 4. Classify converters and identify their applications.

CO 5. Develop different model of different converters to calculate their performance parameter

CO 6. Identify the problems/limitations of power electronics devices, converters and suggest solution

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Power Electronics Lab: 130504

List of Experiments:		
1		Observe effect of gate current, analyse Holding current & Latching current and plot V-I characteristics of S.C.R.
2		Analyse different (1, 2, 3 & 4) modes of operation of a TRIAC , determine break over voltages, holding current, latching current and Plot its V-I characteristics
3		Observe effect of different gate voltages , and plot V-I characteristics of MOSFET
4		Observe effect of different gate Currents, and plot V-I characteristics of IGBT
5		Observe and Analyse the effect on output voltage using SCR and AC Phase control with
	A	R-triggering Circuit (Half wave phase control)
	B	RC- triggering Circuit (Half wave phase control and full wave phase control)
	C	UJT- triggering circuit(full wave phase control)
6		Observe and Analyse dv/dt limitation of SCR and Use of Snubber circuit.
7		Observe and analyse variation in output voltage using TRIAC based AC Phase control with R-load (Lamp load)
8		Realise turn off process of SCR with force commutation different techniques
	A	Class-A commutation (Self commutation by resonating the load)
	B	Class-B commutation (Self commutation by a LC Circuit)
	C	Class-C or Complementary commutation
	D	Class-D commutation or Auxiliary commutation
	E	Class-E commutation or External pulse commutation
9		Observe and Analyse the variation in output voltage for a semi-converter
	A	with Resistive load
	B	Inductive load and Freewheeling Diode
10		To observe and realise the variation in output voltage for a fully controlled bridge converter circuit under Rectification and Inverter mode
11		To observe and Analyse variation in output voltage by changing duty cycle for a SCR based chopper with RL load
12		Observe and analyse the Effect of Pulse width modulation on output voltage for a single phase bridge inverter
13		Realization of Half-wave Rectifier with RL Load using
	A	PSPICE Software
	B	MATLAB Simulink

Course Outcomes:

After completing the course the students will be able to

CO 1. **Demonstrate** VI characteristics of Semiconductor Devices and Various Firing scheme of SCR.

CO 2. **Demonstrate** the performance of various converters AC to DC and DC to AC converter

CO 3. **Compare** the performance of single and three phase VSI Inverter.

CO 4. **Demonstrate** the performance of converters in its different modes of operation.

CO 5. **Prepare** an organized written report.

CO 6. **Develop** the ability to work is team and learns professional ethics.

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100006: Indian Constitution and Traditional Knowledge

100006	Indian Constitution and Traditional Knowledge	Theory	Midterm	Quiz/Assignment	TOTAL	L	T	P	C
		70	20	10	100	3	-	-	-

Course Objectives:

- The course aims to provide students with the continuous, comprehensive and cumulative understanding of Indian Knowledge Tradition (Philosophy, Language, Art) and its modern interpretation and analysis.
- It intends to connect the students' modern advanced knowledge system with the roots of Indian Knowledge Tradition for their development and better understanding of the essentials of thought process, intellection and inference.
- To impart the knowledge of the Yogic Science and an insight into Sanskrit Literature which will promote interest among students in discerning the significance of health and wisdom with an Indian perspective.
- The objective of the syllabus is to familiarize students with the essential features and basic principles of the constitution of India.
- It will acquaint them with the concept of government, its organs and various types.
- It will provide students with a comprehensive and clear understanding of the basic fundamental rights and duties.

Unit-1

- Introduction to Basic Structure of Indian Knowledge System
- Homogeneity of modern science and Indian Knowledge Tradition
- Yoga: Promoting positive health and personality
- Case Studies

Unit-2

- Indian Philosophy or Darshanas: Jainism, Buddhism, Yoga, Śaiva and Vedanta
- Indian Linguistic Tradition: Panini's Ashtadhyayi
- Indian Art: Mauryan art, Buddhist art, Gupta art, Muslim Art & Culture Contemporary art
- Case Studies

Unit 3 Introduction to Political Science

- Nature and scope of political science
- Definition, elements and theories of origin of State (Social Contract and Evolutionary)
- Meaning and features of Civil Society
- Indian Political Thought: Raja Ram Mohan Roy, Swami Vivekanand, Gandhi, Ambedkar

Unit 4 Concept of Government and Its Organs

- Government: Definition and its characteristics
- Types and meaning of Legislature: Composition, Function and Role of the Parliament (Lok Sabha and Rajya Sabha)
- The Powers, Position and Role of the President, Prime Minister and the Cabinet
- The Powers, Position and Role of the Governor and the Chief Minister; Composition and the role of Supreme Court, Judicial Review and Judicial Activism

Unit 5 Salient features of Indian Constitution

- Preamble, Conventions, Sovereignty of the Constitution and the Rule of Law
- Parliamentary Democracy, Federalism, Secularism and Socialism
- Fundamental Rights, Directive Principles of State Policies and Fundamental Duties
- Election Commission and Electoral Reforms

Basic Readings:

1. O.P. Gauba, *Political Theory*, Macmillan, (latest edition).
2. D.D. Basu, *Introduction to the Constitution of India*, (Latest Edition).
3. N.G. Jayal & Pratap Bhanu Mehta, *The Oxford Companion of Politics in India*, 2000.
4. W.H. Morris-Jones, *The Government and Politics of India*.
5. Swami Jitaman and, Holistic Science and Vedam, Bhartiya Vidyabhawan
6. V. Shivramakrishnan (Ed.), Cultural Heritage of India, Bhartiya Vidyabhawan, Mumbai Fifth Edition, 2014.
7. Yoga sutra of Patanjali, Ramakrishnan Mission, Kolkata.
8. Panini Shiksha, Motilal Banarsidas
9. VN Jh, Language, Thought and Reality
10. Krishna Chaitanya. Arts of India, Abhinav Publications, 1987.
11. SC Chaterjee and DM Datta, An Introduction to Indian Philosophy, university of Calcutta, 1984
12. A L Basham, The Wonder That was India

Course Outcomes:

After successful completion of the course, the students will be able to

CO 1. **Know** the rich Indian traditions and the Indian constitution.
CO 2. **Appraise** the utility and significance of tradition and its applicability in present times.
CO 3. **Employ** the knowledge of the constitutional norms as laid in the constitution and abide by the practices stated therein.
CO 4. **Create** a better society and living standards for themselves as well as for others.
CO 5. **Recognize** the basic concepts of ethics and morality pertaining to Indian culture and tradition.
CO 6. **Connect** traditional Indian philosophy with their everyday conduct and practices.

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Departmental Core (DC13)

Switchgear and Protection: 130601

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment	Practical End Sem	Lab Work & Sessional
02	-	02	03	70	20	10	30	20

Course Objectives: To familiarize the students with the learn standard terms and definitions, to understand the need for protection and various protective devices, their construction, operating principle, torque equation, characteristics and field of application for different types of equipments to identify reasons for mal operation and their remedies

Unit I. Arc Interruption : Arc properties , Formation and extinction of arc, Restriking and recovery voltage RRRV, different methods and control devices for arc extinction, Current chopping, Interruption of capacitive currents, Resistance switching. Type and classification of circuit breakers. Oil circuit breaker.

Unit II. Air blast and SF6 circuit breakers: Vacuum circuit breakers, duties and rating Maintenance and testing of OCB 's. Isolators, HRC fuse. Protective Relays: introduction, Definition of terms associated with protective relaying. Construction and characteristics of electromagnetic relays.

Unit III. Elements of static relays: Comparator, induction, distances and differential relays, microprocessor based relays. Modern trends in power system protection, Auto reclosure, under and over frequency relays and their applications. Digital Protection. Numerical protection Introduction, block diagram of numerical relay, numerical over current protection.

Unit IV. Protection schemes: Protection of generators and transformers, percentage differential relay, Buchholz relay, different protections provided for generator and transformer, transmission line protection using over current relays, distance relays and carrier current protection, protection of motors and bus bars.

Unit V. Protection against Over Voltages: Power System transients, Over voltage in transmission lines, fault clearance and lightning and switching surges, ground wire, lightning arrestors, basic impulse insulation level(BIL) , insulation coordination, grounding of P.S. current limiting reactors, their uses and location protection against traveling waves.

Recommended Books:

1. Switchgear protection and power systems by Sunil S. Rao, Khanna publication, 13th edition, 2008.
2. Power system protection & Switchgear by Badriram, TMH publication, 2nd edition, 2011.
3. Switchgear and protection by Ravindranath and Chander, Newage publication, 2nd edition, 2012
4. Switchgear and protection by Deshpande , TMH Publication, 2004
5. Digital Protection by L.P. Singh New Age Publication, 2nd edition, 1997.

Course Outcomes:

After completing this course the students will be able to:

CO 1. **Explain** the concepts, theories and features associated with protective relays and circuit breakers.

CO 2. **Classify** relays and circuit breakers based on criteria such as construction, type of supply, working principle, actuating quantities.

CO 3. **Select** relays and circuit breakers for specific equipments and applications.

CO 4. **Design** protection schemes for generators, motors, transformers and transmission lines.

CO 5. **Analyze** the behavior and performance of relays under different loading levels and faults.

CO 6. **Select** the protective devices and their locations for protecting power systems against over voltages.

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Switch Gear & Protection Lab- 130601

List of Experiments

1. Testing of under voltage relay (electromechanical) at desired fault voltage.
2. Testing of over voltage relay (microprocessor based) at desired fault voltage.
3. Testing of over current relay (electromechanical) at desired fault current.
4. Testing of percentage biased differential relay (Static) at desired biasing.
5. Testing of percentage biased differential relay (Electro-mechanical) at desired basing.
6. Testing of over current relay using the relay test bench.
7. Study of Motor protection simulation panel.
8. Study of Feeder protection simulation panel.
9. Simulation of distance relay and plot the characteristic by using matlab
10. Simulations of IDMT relay and Plot the characteristic using matlab.

Course Outcomes:

After completing the course the students will be able to:-

CO 1. **Operate** the Over/Under voltage & over current relays and observe the performance for different settings

CO 2. **Analyze** the effect of time and current settings on the operating characteristics of an Inverse Definite Minimum Time (IDMT) relay

CO 3. **Validate** the characteristics of percentage biased differential relay for different bias settings.

CO 4. **Prepare** an organized written report.

CO 5. **Develop** the ability to work is team and learns professional ethics.

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Departmental Core (DC14)

Electrical Engineering Materials: 130602

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
02	-	-	02	70	20	10

Course Objective: The Objective is to familiarize the students with different types of materials and their use in the field of Electrical Engineering.

Unit I. Conducting Materials: The conductivity of metals and alloys, Generals properties, Classification of conducting materials, Low resistivity and high resistivity materials, their properties and applications, Electrical and mechanical properties and applications of Cu, Al, Steel, Brass, Bronze, ACSR conductor , AAAC conductor , Tungsten, Molybdenum, Platinum, mercury, lead, manganin, alloys for application in resistances, lamps and electric furnaces, soldering materials, metals and Alloys for fuses, contact materials and their applications, Graphite materials, its properties and application, superconductivity and its applications.

Unit II. Semiconductor Materials: Classification of materials based on atomic structure, conductors, insulators and semiconductors, Electron energy and energy band theory, Excitation of atoms, Semiconductor materials, Intrinsic semiconductors, Extrinsic semiconductor, N type materials, P type materials, minority and majority carriers. Formation of PN junction by alloying, Merits of semiconductor materials for use in electrical Engg., Factors affecting semiconductors, application of semiconductor materials, Hall effect with mathematical treatment.

Unit III. Magnetic Materials: Different terms associated with magnetic materials. Classification of magnetic materials, Diamagnetic, Paramagnetic and ferromagnetic materials, Curie point, Magnetostriction, electromagnet and its uses, Magnetization curve, Hysteresis and eddy current loss, Soft and hard magnetic materials, their properties and applications, alloying silicon to steel, its advantage and disadvantages, requirements of magnetic materials for use in Electrical machines, Grain oriented sheet steel, Magnetic anisotropy, Spontaneous magnetization.

Unit IV. Dielectric materials: Behaviour of dielectrics in static and alternating fields, effect of a dielectric on the behaviour of a capacitor , polarization, Dielectric constant of mono atomic gases, ionic polarization, Dipolar polarization, internal fields in solids and liquids, Polaris ability catastrophe, Frequency dependence of electronic polarization, permittivity, ionic polarization, dielectric losses, significance of the loss tangent dipolar

relaxation, frequency and temperature dependence of the dielectric constant of polar dielectric, Ferro electricity, piezoelectricity.

Unit V. Insulating materials: General electrical, mechanical, thermal and chemical properties of insulating materials, classification of insulating materials on the basis of temperature rise. Gaseous insulating materials properties and application of nitrogen, liquid insulating materials, their main features, Transformer oil, testing the dielectric strength of transformer oil, Fibrous insulating materials, insulating textiles, impregnated fibrous insulating materials, Insulating resins, Classification of synthetic resins (Plastics), thermosetting and thermoplastic resins, adhesives, varnishes and other insulating materials such as mica, ceramic, Bakelite, Ebonite glass, PVC, Rubber.

Recommended Books:

1. A text book of Electrical Engineering materials by P.L. Kapoor, Khanna Publication
2. Electrical Engineering materials by A.J. Dekker , PHI
3. An introduction to Electrical Engineering materials by C.I. Indulkar, S. Thiravengadam, S. Chand & Co.

Course Outcomes:

After completing this course the student will be able to:

CO1 **Discuss** the properties of conducting, insulating, magnetic & semiconducting materials.
CO2 **Explain** applications of conducting, insulating, magnetic & semiconducting material.
CO3 **Describe** the testing of dielectric strength of liquid insulating material
CO4 **Explain** behavior of dielectric material with respect to temperature & frequency.
CO5 **Classify** conducting, insulating, magnetic & semiconducting material.

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ITEM 1: Departmental Electives		
Computer Aided Power System Analysis	Industrial Automation*	Transducers & Sensors

***Industry Collaborative Course**

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DE-1A (130611)

Computer Aided Power System Analysis

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
02	-	-	02	70	20	10

Course Objectives:

- To familiarize the students with the engineering and economic aspects of planning, operation & control of power generation and transmission systems.
- To provide the basic understanding of Artificial Neural Networks and their applications in power system.

Unit I. Unit Commitment and Economic Dispatch: Introduction to unit commitment, statement of unit commitment problem, priority list method, forward dynamic programming, formulation of economic dispatch problem, input-output cost characterization, incremental cost curve, coordination equations with and without loss, solution by direct method and lamda iteration method.

Unit II. Reactive Power Control: Concept of reactive power, control of active power and reactive power - active power and frequency control, flow of reactive power, real power balance and its effect on system frequency; Static VAR systems and their application.

Unit III. Automatic Generation Control (AGC): Frequency dependence of loads, Turbine and speed-governors, Droop control and power sharing, Generation control loops, Load frequency control, AGC, tie-line bias control, AGC in isolated and interconnected power systems, AGC with economic dispatch.

Unit IV. Power System Security: An overview of Power System security, Functions of Operations Control Centre: System monitoring (Normal, Alert, Emergency, Extremis states of a Power System), Contingency Analysis, Security constrained Optimal Power Flow, Factors affecting power system security, Linear sensitivity factors, Application of AC/DC power flow methods, Contingency selection.

Unit V. Applications of Artificial Neural Networks in Power System: Introduction to Artificial neural network (ANN), Types of artificial neural networks, Feed-forward and Feedback ANNs, training and testing of ANNs, Training set generation, ANN applications to power system problems: load forecasting, fault detection, economic load dispatch and voltage security & stability etc.

Recommended Books:

1. Modern Power System Analysis by I.J. Nagrath and D.P. Kothari, Tata McGraw-Hill, 4th ed. 2011.
2. Power System Stability and Control by P. Kundur, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
3. Electric Energy Systems theory –An introduction by Olle. I. Elgerd, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2nd ed. 2004.
4. Power Generation, Operation and Control by Allen. J. Wood and Bruce F. Wollenberg, John Wiley & Sons, Inc., 2006.
5. Power System Analysis Operation and Control by Abhijit Chakrabarti and Sunita Halder, PHI learning Pvt. Ltd., New Delhi, 3rd ed. 2010.
6. Neural computing Theory and Practice by P.D. Wasserman, Coriolis Group, 1989.
7. Introduction to neural networks using Matlab 6.0 by S.N. Sivanandam, S. Sumathi and S.N. Deepa, Tata McGraw Hill Education Pvt. Ltd., New Delhi 2006.

Course Outcomes

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

CO1 **Explain** unit commitment and different methods for Solving UC problem

CO2 **Apply** direct method and lamda iteration method for solving economic dispatch problem

CO3 **Discuss** the concept of reactive power, control of active power and reactive power and SVC

CO4 **Solve** the AGC problem in isolated and interconnected power systems

CO5 **Illustrate** Operations Control Centre functions, System monitoring and Contingency Analysis.

CO6 **Describe** various types of ANN and their applications to power system.

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DE-1B (130612)

Industrial Automation

Course Objective:

- To familiarize the students with the Industrial aspects of automation, planning and model making
- To provide the understanding of the control of a different PLCs and their applications in various low ,medium and high power drives
- To expose the students to understand various sensors, transducers and data acquisition systems and IoT

Pre-requisite: Basics of Power Electronics , digital electronics and Electrical drives

Course Contents:

Unit I:Introduction: Overview of industry environment, Different type of switches & their operation, Architecture of industrial automation system, Relay and contactor logic, AC and DC relays and their role for load control. Review of starters: Power and Auxiliary contactors and their usage for load control. Overview of standards (BIS, ISO) & star and delta starters and their rating.

Unit II:Sensors: Temperature& speed Measurement, Humidity,Pressure, Force and Torque Sensors, Motion Sensing(speed sensor), proximity sensor, Signal Conditioning, Data Acquisition Systems,.Characteristics of Sensors and control logic, control using potential free output sensors, linear potentiometer timer hardware architecture, Controlling industrial system using timers and counters (case study)

Unit III: Industrial Drives: AC & DC Drive basics, Electrical specifications and hardware architecture .AC drive and AC motor specification matching (sizing of drive),Load characteristics and its types, Servo Drives Stepper motor drive and VFD(Variable frequency drives) drives.AC drive power wiring and Interfacing input and output signals. Energy Savings with Variable Speed & multi motor Drives . Braking motoring and regerative operation of drives Selection of power, motor and signal cables for AC drive application. Heat management of Drives, Drives protection

Unit IV: Programmable Logic Controllers: Programmable controllers, Programmable logic controllers, Analog/Digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, , Advantage of using PLC for Industrial automation, Application of PLC to process control industries.Different types of Network Communication Protocol, DH-485, Ethernet, Device Net, Control Net, Modbus, Profibus Proprietary Protocol, open Protocol.

Unit V: Automatic Control: Introduction to P-I-D Control, manual and auto PID Control Tuning, Feed forward Control Ratio Control, Time Delay Systems and Inverse Response Systems, PWM control in drives.

References and Textbooks:

1. Lingefeng Wang, Kay Chen Tan,"**Modern Industrial Automation and Software Design**" John Wiley & Sons Inc.
2. K. L.S. Sharma, **"Overview of Industrial Process Automation"**, Elsevier
3. KokKiong**"Drives and Control for Industrial Automation"**, Springer
4. JOHN WEBB," **Programmable Logic Controllers Principles & applications"**, PHI
5. JOHN G. WEBSTER," **The Measurement, Instrumentation and Sensors Handbook"**, CRC Press.

Course Outcomes:

After completing the course, students are able to:

CO1 **Analyze** architecture of industrial automation system
CO2 **Select** appropriate sensors
CO3 **Acquire** PLC knowledge
CO4 **Acquire** the knowledge of PID control technique
CO5 **Develop** small application using PLC & transducer,
CO6 **Suggest** AC and DC drives for particular applications.

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DE-1C (130613)

Transducers & Sensors

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
02	-	-	02	70	20	10

Course Objective: To make students familiar with the constructions and working principle of different types of **sensors** and **transducers**. To make students aware about the measuring instruments and the methods of measurement and the use of different **transducers.**

Unit 1: Mechanical and Electromechanical transducer & sensor:
Principle of sensing & transduction, classification, Resistive (Potentiometric type): Strain gauge:. Inductive Transducer: Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, LVDT: Proximity sensor

Unit 2: Capacitive transducers & sensors:
Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth, type and cylindrical type, variable dielectric constant type, Stretched diaphragm type: microphone, Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, force & stress sensing, ultrasonic sensors.

Unit 3: Thermal transducers & sensors:
Solid, liquid, gas & vapour, Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister Thermo emf sensor: types,Junction semiconductor type IC and PTAT type. Radiation sensors: types, characteristics and comparison. Pyroelectric type.

Unit 4: Magnetic transducers & sensor:
Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics. Radiation sensors: LDR. Photovoltaic cells, photodiodes, photo emissive cell types, Geiger counters, Scintillation detectors, Introduction to smart sensors

Unit 5: Smart Sensors:
Architecture of Smart Sensors: Features, Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical Vapor, Anodization, Sol-gel Selection of Sensors for Practical Applications, Usefulness of Silicon Technology in Smart Sensor And Future scope of research in smart sensor

Recommended Books:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI
2. Instrument transducers, H.K.P. Neubert, Oxford University press.
3. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill
4. Electronics and Electrical Measurements & Instrumentation, J.B.Gupta, S.K.Kataria & Sons.
5. A Course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney Dhanpat Rai & Co.
6. Transducers and Instrumentation by D.V.S. Murty.

Course Outcomes:

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

1. **Describe** the converting principle of a physical parameter into an electrical quantity
2. **Classify** transducers for measurement of temperature, strain, motion, position and light
3. **Choose** proper sensor to make sensitive measurements of physical parameters like displacement, force, pressure, temperature, acceleration, etc
4. **Predict** correctly the expected performance of various sensors
5. **Identify** different type of sensors used in real life applications and paraphrase their importance

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Disaster Management

100007	Disaster Management (MC)	Theory	Midterm	Quiz/Assignment	TOTAL	L	T	P	C
		70	20	10	100	3	-	-	-

Course objectives:

i) To understand basic concepts in Disaster Management
ii) To understand Definitions and Terminologies used in Disaster Management
iii) To understand Types and Categories of Disasters
iv) To understand the Challenges posed by Disaster
v) To understand Impact of Disasters key skills

Syllabus

Unit 1: Introduction to disaster management, concepts and definitions: disaster, vulnerability, risk severity, frequency and details, capacity impact, prevention, mitigation.

Unit 2: Disasters – Disasters classification, demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends, hazard and vulnerability profile of India.

Unit 3: Disaster Impacts – Disaster impact (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues, impact of natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides etc.), impact of manmade disasters (industrial pollution, artificial flooding in urban areas, urban disasters, transportation accidents etc.).

Unit 4: Disaster Risk Reduction (DRR) - Disaster management cycle- its phases; prevention, mitigation, preparedness, relief and recovery; structural and non- structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response. Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders: Policies and legislation for disaster management. DRR programmes in India and the activities of National Disaster Management Authority.

Unit 5: Disasters, Environment and Development – Factors affecting vulnerability such as impact of development projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

Course outcomes:

After successful completion of the course, the students will be able to

1. Propose disaster prevention and mitigation approaches.
2. Classify global and national disasters, their trends and profiles.
3. Appreciate the impacts of various disasters.
4. Apply Disaster Risk Reduction in management.
5. Find the linkage between disasters, environment and development.

Text Books:

1. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
2. Ghosh G.K., 2006, Disaster Management , APH Publishing Corporation
3. Srivastava H.H. & Gupta G.D., Management of Natural Disasters in developing countries, Daya Publishers Delhi, 2006, 201 pages.

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Electrical Engineering Department

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For batches admitted in Academic Session 2018-2019 & 2019-2020

Reference Books:

1. http://ndma.gov.in (Home page of National Disaster Management Authority)
2. http://www.ndmindia.nic.in / (National Disaster Management in India)
3. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
4. National Disaster Management Policy, 2009, GOI.
5. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Setting. Geneva: IASC

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Electrical Engineering Department

Scheme of Examination

For batches admitted in Academic Session 2018-2019 & 2019-2020

Courses & Syllabi to be offered under Open Category (OC) Courses for VI semester

1. OC-A: 900103: Energy Conservation & Management
2. OC-B : Biomedical Instrumentation

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Electrical Engineering Department

Scheme of Examination

For batches admitted in Academic Session 2018-2019 & 2019-2020

OC-A

Energy Conservation & Management /900103

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
02	-	-	02	70	20	10

Course Objectives:

To familiarize the students to the concepts of Energy Audit, various terminology, rules and regulations, policy, energy economics, energy tariff, analysis techniques and energy conservation.

Unit I. Energy Scenario: Classification of Energy, Indian energy scenario, energy needs of growing economy, long term energy scenario, energy conservation and its importance, Energy conservation Act 2001 and its features, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, Electricity Acts, National action plan on climate change.

Unit II. Energy Sources & conservation: Conventional & Non Conventional sources of energy, Renewable & non renewable source of energy, Various methods of energy Conservation, Generation of Electrical Energy using non-conventional Sources.

Unit III. Energy Audit: Introduction, Energy Audit- Need, Scope, Methodology, Types of Energy Audit, Energy Flow Diagram, Baseline data for energy audit, Instruments for energy auditing. Sankey Diagram, Questionnaire for energy audit, Preparations & presentations of energy audit reports, Functions of Energy Auditor

Unit IV. Energy Management: Definition and objective of energy management, General Principles of energy Management, Energy Management Approach, Energy supply side Management, Management of energy distribution, Functions of energy management team.

Unit V. Energy Economics: Introduction, Parameters for energy economics, Energy Tariff, Economic Analysis Technique- Simple payback period, Discounted Cash Flow Method or Time Audited Technique (Net present value NPV, Present value index method PI, Internal rate of return Method IRR), Return on Investment (ROI).

Recommended Books:

1. Energy Management by W. R. Murphy, G. A. Mckay, Butterworth, 2nd ed., 2009.
2. Energy Management Principles by C.B. Smith, Pergamon Press, 2nd ed., 2015.
3. Electrical Energy Conservation & Utilization by S.C. Tripati, McGraw Hill Edu. India, 1st ed., 1980.

4. Non-Conventional Energy Resources by N. K. Bansal, Laxmi Publication, 1st ed., 2014.
5. Energy Management Hand book by W.C. Turner, John Wikey& Sons, 6th ed., 2006.
6. Energy Conservation guide book by Pattrick, Prentice Hall, 1st ed. 1993.

Course Outcomes:

After the completion of the course, the student will be able to –

CO 1. **Explain** the basic concepts of Energy Audit & its various terminologies, rules and regulations, policy and how to write reports.

CO 2. **Acquire** fundamental knowledge on the science of energy and on both the conventional and non-conventional energy technologies

CO 3. **Describe** different energy auditing methods and the implementation procedures

CO 4. **Identify** present scenario of energy utilization, management and corresponding ACT of regulatory commission

CO 5. **Recognize** process billing, energy tariff and power factor improvements to achieve energy efficient systems.

OC-B

Biomedical Instrumentation

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Electrical Engineering Department

Scheme of Examination

For batches admitted in Academic Session 2018-2019 & 2019-2020

OC (B)

BIO-MEDICAL INSTRUMENTATION

L	T	P	Total Credits	Theory End Sem	Mid Sem	Quiz/Assignment
02	-	-	02	70	20	10

Course Objectives: To introduce students to the basic biomedical engineering technology and different biological signals, their acquisition, measurements and related constraints.

Unit I. Introduction to Biomedical Electrodes & Transducers: Development of biomedical instrumentation, Man-Instrument System, Problems Encountered in Measuring a Living System, transducers for biomedical applications; origin of biopotential and its propagation, sources of bioelectric potentials, electrocardiogram, electro encephalogram, electromyogram and other bioelectric potentials. Biopotential Electrodes, the nervous system , Instrumentation for sensory measurements.

Unit II. Cardiovascular System & Measurement: The Cardiovascular system, ECG lead configuration, ECG recording, (Einthoven Triangle) Mechanical & electrical Activity of the Heart, electrocardiography, measurement of blood pressure, blood flow and cardiac output, plethysmography, heart sounds, pacemakers and defibrillators.

Unit III. Measurements in the Respiratory System: Respiratory Mechanism, measurements of gas volume, flow rate, carbon dioxide and oxygen concentration in exhaled air, respiration controller, spirometer, respiratory therapy equipments, inhalators, ventilators & respirations, humidifiers, nebulizers &Aspirators.

Unit IV. Patient Care, Monitoring and Safety: Elements of intensive care, Monitoring, Hospital System & components, Electrical safety of patients & medical equipment, physiological effects of electric current, shock hazards from equipments, Patient care and monitoring: elements of intensive care unit, safety measures.

Unit V. Noninvasive Diagnostic Instrumentation : Ultrasonic Waves and Ultrasonic Vibrations , Propagation, Acoustic Intensity, Applications, Super Imposition, Potential Health Hazard, Measurement of Velocity, Ultrasonic Scanning techniques for bone fracture detection, Applications, Comparison between X-rays and ultrasonic scanning, Applications, Ultrasonic Cleaning, digital radiography Medical Imaging equipments Method.

Recommended books:

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd ed., 1980.
2. Biomedical Instrumentation: Technology and Applications by Raghbir Singh, McGraw-Hill Education, 1st ed., 2004.
3. Medical Instrumentation for Health Care by Leslie Cromwell, Prentice Hall, 1st ed, 1976.
4. Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation by Robert B. Northrop, CRC Press, 2nd ed., 2012.
5. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris, 2nd ed., 1978.
6. Clinical Neurophysiology, U K Mishra, Elsevier.

Course Outcomes:

After completing this course the student will be able to:

CO 1. Describe the origin of biopotentials and the role of biopotential electrodes & transducers

CO 2. Analyze common biomedical signals and distinguish characteristic features;

CO 3. Describe the physical and medical principles used as a basis for biomedical Instrumentation

CO 4. Explain measurement principles for blood flow, pressure and volume as well as respiratory variables

CO 5. Identify the patient safety issues related to biomedical instrumentation

CO 6. Explain the different ultrasonic scanning & medical imaging systems

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Electrical Engineering Department

Electrical Drives: 130711

Course Objectives:

- To provide an over view of complete electrical drive systems to students, including the mechanical parts, electrical machines, and power converters and control.
- To expose the students to the basic and advanced speed control techniques using power electronic converters that are used in industry.
- Tofamiliarizethestudentswiththeconceptsbehindfourquadrantsoperationofelectricdrivesandslip power recovery schemes in induction motors.

Unit I. Basic Concepts: Elements of drive system, Requirements of electric drives. Ratings and selection of drives, Group and individual drives, constant power and constant torque drive. Dynamics of Electric drive convention and multi quadrant operation. Transient and steady state stability of Electrical drive. Control of Electrical drive, modes of operation, speed control and drive classification, closed loop control of drive.

Unit II. DC Drives: DC motor drives, DC motor and their performance, starting, braking, transient analysis and control, Ward Leonard drives, Thyristorised controlled DC drives, chopper controlled DC drives.

Unit III. Induction Motor Drives: Three phase induction motors Drives, starting, braking, transient operation, Variable frequency control from voltage and current source, rotor resistance control, static Scherbius and Kramer drives, introduction to vector control.

Unit IV. Synchronous Motor Drives: synchronous motor drives, synchronous motor operation from fixed frequency supply, synchronous variable speed drives, self-controlled synchronous motor drives, brushless DC motor, stepper motor and switched reluctance motor drives.

Unit V. Special Drives: Solar and battery powered drives, solar powered electrical vehicles and boat, Traction Drives nature of traction load, conventional DC and AC Traction drives, Energy conservation in electric drives, Servo drives.

Recommended Books:

1. Fundamentals of Electrical Drives by G.K. Dubey, CRC Press, 2nd Ed.2007
2. A first course in Electric Drives by S.K. Pillai, New Age International, 2nd Ed.2007
3. Power Electronics and AC Drives by B.K. Bose, IEEE Press, Newjersey,2001
4. Electrical Drives Concept & Application by Vedam Subrahmanyam,TataMcgrawHill, 2nd Ed.2011.

Course Outcomes:

After the completion of the course, the student will be able to –

CO 1. **Describe** various components of a drive system along with modes of operation, control needs and identify stable/unstable regions

CO 2. **Explain** various drives & loads, their characteristics and control methods under various operating

CO 3. **Explain** performance analysis & control of dc drives

CO 4. **Explain** performance analysis & control of ac drives

CO 5. **Describe** working static converters for speed control of different types of drives

CO 6. **Explain** the functioning of solar, battery powered and traction drives and explain energy conservation methods

Renewable Energy Systems: 130712

Course Objectives: To impart the knowledge on various forms of renewable energy sources and the process of electric energy conversion.

Unit I. Environmental aspects of electric power generation: conventional sources: Limitation of fossil fuels. Atmospheric pollution – effects of hydro-electric projects – disposal of nuclear waste – green house gaseous mission from various energy sources and its effects–need for renewable energy sources.

Unit II. Solar Photo-Voltaic system: Solar radiation and its measurement – Angle of sun rays on solar collector–optimal angle for fixed collector–sun tracking, an introduction to solar cell, solar PV module, PV system design and applications–stand-alone and grid connected systems, environmental impacts.

Unit III. Wind power generation: Wind energy, classification of wind turbines – aerodynamic operation of wind turbine, extraction of wind turbine power, wind turbine power curve, horizontal axis wind turbine generator – modes of wind power generation – stand-alone and grid connected system, environmental impacts.

Unit IV. Fuel cell system: Principle of operation of fuel cell, technical parameters of fuel cell, Type of fuel cell – advantages of fuel cell power plants, energy output, efficiency and emf of fuel cell – operating characteristics, applications and environmental impacts.

Unit V. Hybrid energy systems: Need for hybrid systems, types, configuration and coordination, electrical interface – PV-Diesel, Wind-diesel, wind-PV, wind-PV- fuel cell.

Recommended Books:

1. Non-conventional Energy sources by G D Rai, Khanna Publishers, 5th ed.,2014.
2. Renewable Energy Sources and Emerging Technologies by D.P. Kothari, K.C. Singal and R. Ranjan, PHI, 2nd ed.,2012.
3. Solar Photo-Voltaics–Fundamentals, Technologies and Applications by C.S. Solanki, PHI Pvt.,Ltd., 2nded., 2011.
4. Wind Electric Systems by S N Bhadra, D Kastha and S Banerjee, Oxford Publications,2nd ed.,2007.

Course Outcomes:

Upon the completion of this course the student will be able to:

CO 1. **Evaluate** the environmental impacts of conventional energy sources and the need of renewable energy
CO 2. **Explain** the process of PV generation, wind power generation
CO 3. **Describe** stand-alone and grid connected configuration
CO 4. **Explain** the process of fuel cell power generation and its applications.
CO 5. **Identify** the need of hybrid energy systems.

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Electrical Engineering Department

IoT in Microgrid: 130713

Course Objectives:

- To provide the basic concepts of Microgrid, its configuration, operation and control.
- To familiarize the students with energy storage devices, smart metering and IoT application in Microgrid.

Unit I. An Overview of Microgrid: Concept of Microgrid, Typical structure and configuration of a Microgrid, Significance of Microgrid, Sources of microgrid, Types of Microgrids, AC, DC and hybrid Microgrids.

Unit II. Microgrid Operation and Control: Modes of Operation: Grid Connected Mode, Islanding Mode, Issues in Island Mode of operations, Control laws, Power relations and power control, Bi-directionality and its need in a Microgrid, Control of DC-DC converters and inverter and challenges in a Microgrid, Microgrid Control Strategies: Centralized, Decentralized and Hierarchical control.

Unit III. Energy Storage for Microgrid: Role of energy storage systems AND their applications in Microgrid, Overview of energy storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical, Battery Energy Storage Systems (BESS), Superconducting Magnetic Energy Storage (SMES), Compressed Air Energy Storage (CAES)

Unit IV. Introduction to IoT: Architecture of IoT, Communication network: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network (FAN), Wide Area Network (WAN), Wireless Sensor Networks (WSNs)

Unit V. IoT in Microgrid: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart Appliances. Smart sensors: home & building automation, plug in hybrid electric-vehicles (PHEV), algorithms for vehicle to grid and grid to vehicle management, smart charging stations.

Recommended Books:

1. Microgrids: Architectures and Control by Nikos Hatziargyriou, Wiley-IEEEPress,2013
2. Microgrid: Advanced Control Methods and Renewable Energy System Integration by Magdi S. Mahmoud, Butterworth-Heinemann,2016
3. Microgrids and Active Distribution Networks by S. Chowdhury, P. Crossley, IET Press, 2010
4. Design of Smart Power Grid Renewable Energy Systems, AliKeyhani, JohnWiley&Sons,2011
5. Smart Grid: Infrastructure, Technology and Solutions by Stuart Borlase, CRC Press 2012.
6. Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama,Wiley

Course Outcomes:

After the completion of the course, the student will be able to

CO 1. Identify the role and significance of microgrid in future power systems

CO 2. Describe different types and modes of operation of Microgrids

CO 3. **Explain** the different control strategies available for Microgrid
CO 4. **Select** proper energy storage devices for smooth operation of microgrid
CO 5. **Describe** applications of IoT in Microgrid

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Electrical Engineering Department

Intelligent Sensors and Instrumentation:130714

Course Objective: To familiarize students with the state of art of smart, intelligent and network sensors, and instrumentation systems and their design.

Unit I. Sensor, Actuator and Transducer: Classification of sensors on the basis of energy source and type of output signals; Signal conditioning; Meaning and types of smart sensors, Neuro-sensors, Biosensors

Unit II. Smart Sensor Technologies: Thick-film, thin-film and monolithic IC technologies and their use in making smart sensors; Bulk and surface micromachining technologies, wafer bonding, LIGA process, plasma etching, and their use in making smart sensors.

Unit III. MEMS, Intelligent and Network Sensors: Concept and methods of making MEMS devices, sensors and actuators, Concept and architecture of intelligent sensors; Concept and architecture of network sensors; Examples.

UnitIV.SensorNetworking:7-Layer OSI model of communication system, device-level networks, introduction to protocols and technologies for wired and wireless LANs; Ethernet, RS-485 and Foundation Field bus protocols; Wi-Fi; Zigbee and Bluetooth protocols; Concept of adhoc networks; Smart Transducer Interface Standard IEEE1451.

Unit V. Intelligent Instrumentation: Introduction meaning and advantages; Microprocessor application techniques; I/O techniques; Interfacing of I/O devices, Nano-technology, soft computing techniques in instrumentation.

Recommended Books:

1. Fraden J., "Handbook of Modern Sensors: Physics, Design and Applications", AIP press, 2003.
2. Frank R., "Understanding Smart Sensors", Artech House publishers,2000.
3. Yamasaki H., "Intelligent Sensors", Elsevier Eastern Limited,1996
4. Ramon P.A. and Webster J.G., "Sensors and Signal Conditioning" John Wiley and Sons, 2nd2001Ed.
5. FengZ. and Leonidas G., "Wireless Sensor Networks", Elsevier Eastern Limited,2007.
6. Barney G., "Intelligent Instrumentation", Prentice-Hall International Editions,1998.

Course Outcomes:

After completing this course students will be able to:

CO 1. **Describe** transduction principle of sensor based on various energy forms.
CO 2. **Explain** Smart Sensor Technologies
CO 3. **Explain** the MEMS, Intelligent and Network Sensors
CO 4. **Identify** the component of sensor networking
CO5. **Discuss** Intelligent Instrumentation techniques

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Electrical Engineering Department

Applications of Electrical Equipment &Motors: 900205

Course Objectives: To impart knowledge on electrical appliances and their applications, safety on electrical equipments, electric motors, traction system considering economic and technology up gradation.

Unit I. Safe Working on Electrical Equipments: - Authorized Person, procedure for shutdown, testing devices for electricity, special shutdown precautions in substations and Power House, safety measures on LV & HV electrical equipments

Unit II. Utility of electrical equipments: Electrical motors, transformers, cables, and generators, motor control centers, medium voltage distribution panels, power control centers, Motor used in Electric vehicle, Electrical wiring components and accessories, Modern Appliances: Troubleshooting and Maintenance, Electrical Safety: Standards and Regulations

Unit III. Substation Equipment: Bus bar: Temperature rise test, rated short time current test, HV test, Power frequency voltage with stand test, Earthling Equipment, Isolator testing equipment, switch gear equipment: relay, CT, PT

Unit IV. Electric Motors Drives: Introduction, Individual and group drive, Factor affecting selection of motor, Types of loads, Revised study of speed torque characteristics of DC and AC motor, Transient Characteristics, size and rating of motors, continuous & intermittent rating, Temperature rise calculation, Load Equalization, Motor enclosures

Unit V. Electric Traction Equipment: Introduction, requirements of an ideal traction system, supply systems for track-electrification, Comparison and application of different systems, Train Movement: speed time and speed distance curves, average and schedule speed, Mechanics of train movement: energy consumption Tractive effort, Factor affecting specific energy consumption, Coefficient of adhesion, Types of motors used for electric traction, current collection systems

Recommended Books:

1. Art and Science of Utilization of Electrical Energy by H. Pratab, Dhanpat Rai and Company, 2nd Ed., 2007.
2. Electric Power Utilization by N.N. Hanock, Wheeler publishing, 1st Ed.,1967.
3. Utilization of Electric energy by E. Openshaw Taylor, Orient Longman,1st Ed.,1961.
4. Generation Distribution and Utilization of Electrical Energy by C.L. wadhwa, New Age publications, 1st Ed.,1989.

Course Outcomes:

After the completion of the course, the student will be able to:

CO 1. Know the various types of electrical equipments and their suitable applications.

CO 2. Describe the various schemes of AC, DC drives, traction schemes and different braking systems

CO 3. Explain the basics of lighting and illumination and its parameters and able to design Illumination systems for various applications.

CO 4. Gain knowledge of the various types of arc furnaces, electrical welding, various types of heating.

CO 5. Apply the electrical energy applications for traction and understand the power electronics technology in efficient utilization of electrical power.

CO 6. Identify the knowledge for research opportunities in field of electric traction & utilization of Electric energy

IoT in Microgrid: 900216

Course Objectives:

- To provide the basic concepts of Microgrid, its configuration, operation and control
- To familiarize the students with energy storage devices, smart metering and IoT application in Microgrid

Unit I. An Overview of Microgrid: Concept of Microgrid, Typical structure and configuration of a Microgrid, Significance of Microgrid, Sources of microgrid, Types of Microgrids, AC, DC and hybrid Microgrids.

Unit II. Microgrid Operation and Control: Modes of Operation: Grid Connected Mode, Islanding Mode, Issues in Island Mode of operations, Control laws, Power relations and power control, Bi- directionality and its need in a Microgrid, Control of DC-DC converters and inverter and challenges in a Microgrid, Microgrid Control Strategies: Centralized, Decentralized and Hierarchical control

Unit III. Energy Storage for Microgrid: Role of energy storage systems AND their applications in Microgrid, Overview of energy storage technologies: Thermal, Mechanical, Chemical, Electrochemical, Electrical, Battery Energy Storage Systems (BESS), Superconducting Magnetic Energy Storage (SMES), Compressed Air Energy Storage (CAES)

Unit IV. Introduction to IoT: Architecture of IoT, Communication network: Home Area Network (HAN), Neighborhood Area Network (NAN), Field Area Network (FAN), Wide Area Network (WAN), Wireless Sensor Networks (WSNs)

Unit V. IoT in Microgrid: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart Appliances. Smart sensors: home & building automation, plug in hybrid electric vehicles (PHEV), algorithms for vehicle to grid and grid to vehicle management, smart charging stations.

Recommended Books:

1. Microgrids: Architectures and Control by Nikos Hatziargyriou, Wiley-IEEE Press,2013
2. Microgrid: Advanced Control Methods and Renewable Energy System Integration by Magdi S Mahmoud, Butterworth-Heinemann,2016
3. Micro grids and Active Distribution Networks by S. Chowdhury, P. Crossley, IET Press,2010
4. Design of Smart Power Grid Renewable Energy Systems, Ali Keyhani, JohnWiley&Sons,2011
5. Smart Grid: Infrastructure, Technology and Solutions by Stuart Borlase, CRC Press2012.
6. Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley.

Course Outcomes:

After the completion of the course, the student will be able to

CO 1. **Define** the role and significance of microgrid in future power systems
CO 2. **Identify** different types and modes of operation of Microgrids
CO 3. **Illustrate** the different control strategies available for Microgrid
CO 4. **Select** proper energy storage devices for smooth operation of microgrid
CO 5. **Compare** various communication networks: HAN, NAN, FAN, WAN and WSNs
CO 6. **Describe** various applications of IoT in Microgrid

Electric Vehicles: 900217 (Old Syllabus)

Course Objectives: To impart knowledge on areas like how to choose a suitable drive scheme in developing electric vehicles depending on resources to develop basic schemes, design proper energy storage systems and usage of various protocols of communication under the umbrella of electrical vehicles.

Unit I: Background of EVs

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles. Advantages & Disadvantages of EVs, Electric Revolution, Types of EVs (Plug-in EVs, ground vehicles, air borne, sea borne, Hybrid EVs, on-and-off road EVs), and Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

Unit II: Electric Drive-Trains & Propulsion

Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, Tractive effort, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

Unit III: Energy Storage & Management

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Charging of electric Vehicles, Battery based energy storage and its analysis, Fuel cell based energy storage and its efficiency analysis, Battery Management System, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies. Vehicle to grid (V2G) and Grid to Vehicle (G2V) fundamentals.

Unit IV Vehicle Dynamics

Acceleration & Braking, Suspension of EVs, Steering of EVs, Ride Comfort, Dynamic equation, Driving Cycle and range.

Unit V Sizing & Selection

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications.

Recommended Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.

Course Outcomes:

After completion of the course, the student will be able to

- **CO 1.** **Interpret** the environmental importance of electric vehicles and their role in society.
- **CO 2.** **Define** electric drive train topologies and propulsion mechanisms used in EVs
- **CO 3.** **Design** energy storage and management strategies for V2G and G2V concepts.
- **CO 4.** **Analyze** dynamics of EVs for constant and variable tractive efforts.
- **CO 5.** **Select** different components and sizes of EVs.
- **CO 6.** **Design** basic modeling of vehicle dynamics in simulink.

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Electrical Engineering Department

Electric Vehicle: 900217 (Revised syllabus)

Course Objectives: To impart knowhow to choose a suitable drive scheme in developing electric vehicles depending on resources to develop basic schemes, design proper energy storage systems and usage of various protocols of communication under the umbrella of electrical vehicles.

Unit I: Background of EVs: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles. Advantages & Disadvantages of EVs, Electric Revolution, Types of EVs (Plug-in EVs, ground vehicles, airborne, seaborne, Hybrid EVs, on-and-off road EVs), and Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

Unit II: Electric Drive-Trains & Propulsion: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, Tractive effort, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

Unit III: Energy Storage &Management: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, charging of electric Vehicles, Battery based energy storage and its analysis, Fuel cell-based energy storage and its efficiency analysis, Battery Management System, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies. Vehicle to grid (V2G) and Grid to Vehicle (G2V) fundamentals.

Unit IV Vehicle Dynamics & charging: Electric Vehicle Dynamics: Acceleration, Braking, Suspension & Ride Comfort;

Electric Vehicle charging: Introduction, Slow/ fast chargers, Swapping, Standardization, On board chargers, Public Chargers, Bulk chargers.

Unit V Sizing &Selection Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications.

Recommended Books:

1. Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Hussein, CRC Press, 2003.
2. Electric Vehicle Technology Explained by James Larminie, John Lowry, Wiley, 2003.
3. Modern Electric, Hybrid Electric and fuel Cell Vehicles: Fundamentals, Theory and Design by Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 2005.

Course Outcomes:

After completion of the course, the student will be able to

CO 1. Interpret the environmental importance of electric vehicles and their role in society.

CO2.DefineelectricdrivetraintopologiesandpropulsionmechanismsusedinEVs

CO3.DesignenergystorageandmanagementstrategiesforV2GandG2Vconcepts.

CO 4. Analyze dynamics of EVs for constant and variable tractive efforts.

CO 5. Select different components and sizes of EVs.

CO 6. Design basic modeling of vehicle dynamics in Simulink.