Shivaji University, Kolhapur
Structure for Electrical Engineering Programme
T.E. (Electrical Engineering)
to be implemented from 2015-16

Semester V

Sr. No	Category	Course Title	L	T	P	Contact Hours	Theory	TW	POE	Total
							Theory	TW	POE	Total
1	EE	Digital Electronics and Microcontroller	3		2	5	100	25		125
2	EE	AC Machines	4		2	6	100	25	50	175
3	EE	Power Systems II	4		2	6	100	25	50	175
4	EE	Control System II	4		2	6	100	25		125
5	EE	Signals and Systems	3	1		4	100	25		125
6	EE	Software tools for Electrical Engineers			2	2		75		75
			18	1	10	29	500	200	100	800

(The "Evaluation Scheme" spans the Theory, TW, POE, Total columns.)

Semester VI

Sr. No	Category	Course Title	L	T	P	Contact Hours	Theory	T W	POE	Total
							Theory	T W	POE	Total
1	EE	Advanced Electrical Measurements	4			4	100	25		125
2	EE	Communication Engineering	3		2	5	100	25		125
3	EE	Electrical Machine Design	3	1	2	6	100	50	50	200
4	EE	Power System III	4		2	6	100	25		125
5	EE	Electrical Drives	4		2	6	100	25	50	175
6	EE	Electrical Workshop			2	2		50		50
			18	1	10	29	500	200	100	800

(The "Marks" heading spans the Theory, T W, POE, Total columns.)

Note:-During vacation after VI semester the candidate should undergo minimum 3 weeks training in any industry and submit its report along with presentation to the department immediately after commencement of VII Semester.

SEMESTER-V

1. DIGITAL ELECTRONICS & MICROCONTROLLER

Teaching Scheme	Examination Scheme
Lectures: 03 hrs/week	Theory : 100 marks
Practical: 02 hrs/week	Term Work: 25 marks

Unit 1: Boolean algebra & logic

Introduction to number system- binary, octal, hexadecimal. Logic gates and truth tables. Basic theorems and properties of Boolean algebra. Boolean functions. Canonical and standard forms. Digital logic gates. IC digital logic families. (05)

Unit 2: Simplification of Boolean functions

The map method. 2 and 3 variable maps. 4 variable maps. Product of sums and sum of products simplification. Don't care conditions. (04)

Unit 3: Combinational logic & Sequential logic

Introduction, Design procedure, adders, subtractors, code conversion. Analysis procedure. Ex-OR and equivalence functions. Binary parallel adder, decimal adder, magnitude comparator, decoders, multiplexers, ROM. Introduction, Flip Flops, Triggering of Flip Flops, Design of counters. Shift registers, ripple counters, synchronous counters. (10)

Unit 4: 8051 Architecture and Instructions

8051 architecture- features, pins and signals, program and data memory organization, system clock.SFR, PSW, registers, ports and addressing modes. Instructions. Interrupts, counter/ Timer, Serial communication. (07)

Unit 5: Assembly Programming Examples

Copy block, shift block, count no. of nulls, find checksum, sum of natural numbers, sum of a series, Fibonacci series, generate a series. Count 1s in a byte, find largest / smallest integers of an array. Bubble sorting, find sum of factorials. Compare with external array, reverse an array. Sum of a series, generate prime numbers. (08)

Unit 6: Interfacing

Interfacing- external memory, keyboard, display devices, DAC/ADC, dc motor, stepper motor, servomotor. Introduction to power management. (08)

Text books:

1. Digital Logic and Computer Design, Morris Mano, PHI publications
2. Modern digital electronics, R.P. Jain, TMH Publications
3. Fundamentals of digital circuits, Anand Kumar, PHI
4. The 8051 Microcontroller and embedded systems, Muhammad Ali Mazidi, Pearson Education

Reference books:

1. Digital Electronics: Principles & Integrated Circuits, A. K. Maini, Wiley Publications
2. Digital Systems- Principles and Design, Rajkamal, Pearson Education
3. The 8051 Microcontroller Architecture, Programming and Applications, Kenneth Ayala, Penram International, 2nd Edition
4. 8051 Microcontroller: Internals, Instructions, Programming and Interfacing, Subrata Ghoshal, Peasrson Publications

Term work:

The term work shall consist of 12 experiments out of which 04 based on Digital Electronics, 04 on 8051 programming and 04 on interfacing.

2. AC MACHINES

Unit-1

Construction & types of 3 ph. Induction motors, Rotor quantities (emf ,current, frequency, pf), torque equation, starting torque, running torque (numerical treatment) , Factors affecting torque, condition of maximum torque ,torque slip characteristics, Need of starters for 3 phase. Induction motors, types of starters (DOL, autotransformer, star-delta, rotor resistance starter, Speed control methods from stator side (Stator voltage control Stator Frequency control, Pole changing) & rotor side (rotor resistance control), Applications of 3 ph. Induction motors   (11)

Unit-2

Losses & efficiency of 3 phase induction motor, power flow diagram with numerical treatment, No load & blocked rotor test, equivalent circuit of 3 phase induction motor, Phasor diagram of 3 phase induction motor, performance of 3 phase induction motor using circle diagram, Concept of operation of 3 phase induction motor as induction generator, Double cage induction motor along with its characteristics, cogging & crawling of 3 phase induction motor   (10)

Unit-3

Double field revolving theory, types of single phase induction motor (Split phase, capacitor start/run, shaded pole motors)   (05)

Unit-4

Construction, principle of operation of three phase alternator, emf equation, parameters of armature winding. (resistance & leakage reactance), armature reaction (at unity, lagging zero and leading zero power factor), concept of synchronous reactance and synchronous impedance. Equivalent circuit of 3 phase alternator, alternator on load (resistive, inductive & capacitive) (06)

Unit-5

OC test & SC test on 3 Phase alternator, short circuit ratio, voltage regulation methods (emf, mmf, zero power factor and direct loading method) with numerical treatment, Losses and efficiency, power flow diagram, need of parallel operation, conditions for parallel operation, synchronizing procedures, hunting and oscillations in alternators (theoretical treatment)   (08)

Unit-6

 Principal of operation of three phase synchronous motor, staring methods of three phase synchronous motors (using prime mover and damper winding, Phasor Diagram of three phase synchronous motor at Unity, lagging and leading power factor, Effect of excitation on power factor and armature current, V & inverted V Curves, Operation of Synchronous motor as Synchronous Condenser, Application of three phase synchronous motor   (08)

Text Books:

1. Electical Machines, S. K. Bhattacharya, Tata Mc-Graw-Hill publication III edition
2. Electrical Technology Vol.II, B. L. Theraja, S. Chand Publications
3. Electrical Machines, I. J. Nagrath, D. P. Kothari, Tata Mc-Graw-Hill publication IV edition

Reference books:

1. Electric Machinery, A. E. Fitzgerald, Mc-Graw Hill publications VI edition
2. Electrical Machinery, P S Bhimbhra, Khanna Publications
3. Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Sons

Term work:

Minimum eight experiments from the following list of experiments should be performed in the laboratory:

1. Determination of efficiency & speed regulation of 3 phase Sq. cage induction motor (SCIM) by direct loading method
2. Determination of efficiency & speed regulation of 3 phase SCIM by indirect loading method
3. Determination of equivalent circuit parameters of 3 Ph SCIM by conducting No Load & Blocked Rotor Test.
4. Determination of efficiency & speed regulation of 3 phase slip ring induction motor by direct loading method.
5. Determination of efficiency & speed regulation of 3 phase slip ring induction motor by indirect loading method.
6. Study of starters for 3 Ph induction motors.
7. Performance of three phase induction motor under single phasing fault.
8. Speed control methods of 3 Ph. SCIM.
9. Speed control methods of 3 Ph. Slip ring I.M
10. Determination of efficiency & speed regulation of 1 phases induction motor.
11. Determination of Voltage regulation of an alternator by EMF method.
12. Determination of Voltage regulation of an alternator by MMF method
13. Determination of Voltage regulation of an alternator by ZPF method.
14. Determination of Xd and Xq by Slip test
15. Performance of synchronous generator connected to infinite bus, under constant power and variable excitation & vice - versa.
16. Determination of V and Inverted V curves of a synchronous motor.
17. Determination of efficiency of synchronous motor by indirect loading
18. Determination of efficiency of synchronous motor by direct loading
19. Determination of load sharing by parallel operation
20. Determination of efficiency of Alternator by direct loading method

3.POWER SYSTEM II

Teaching Scheme	Examination Scheme
	Theory : 100 marks
Lectures: 04 hrs/week	Term Work: 25 marks
Practical: 02 hrs/week	POE: 50 marks

Unit-1 Representation of Power system Components

Single phase representation of Balanced 3 phase Networks, OLD & Impedance & Reactance Diagram, Per Unit System- P.U. Representation of Transformer, P.U. Impedance Diagram of Power system, Steady State Model of Synchronous Machine, Representation of Loads, Numerical treatment expected   (04)

Unit-2 Symmetrical Fault Analysis

Short circuit transients on transmission line Short Circuit on Unloaded Synchronous machine, Short Circuit on loaded Synchronous machine **,** Selection Checklist for circuit breaker, Short circuit MVA, Algorithm for Short circuit studies **,** Z- Bus Formulation, Numerical treatment expected   (08)

Unit-3 Symmetrical Components

Sequence Impedances Synchronous machine. Sequence Impedances Transformer, Construction of Sequence network of Power Systems, Numerical treatment expected   (08)

Unit-4 Unsymmetrical Fault Analysis

Symmetrical component analysis of Unsymmetrical Faults, Analysis of Single Line to Ground (LG) fault, Line-To-Line (LL) fault, Double-Line-To-Ground (LLG) fault, One conductor open fault, Bus Impedance Matrix for analysis of Unsymmetrical shunt faults, Numerical treatment expected   (10)

Unit-5 Load Flow Analysis

Load flow problem, Gauss-Seidel Method, Newton-Raphson Method, Decoupled Load Flow studies, Fast Decoupled Load Flow studies. Comparison of Load Flow methods, Numerical treatment expected   (12)

Unit-6 Substation Engineering

Substation Grounding, Direct Lightning stroke shielding of substations, Role of Substations in Smart Grids.   (06)

Text Books:
1. Modern Power System Analysis ,   D. P. Kothari, I. J. Nagrath, Mc-Graw Hill Publications , Fourth Edition
2. Power System Analysis, Hadi Saadat, Tata Mc-Graw Hill
3. Electric Power substations Engineering, John D. McDonald, CRC Press , Third Edition

Reference Books:

1. Electrical Transients in Power Systems, Greenwood, Wiley Publication II edition
2. Power System Stability Vol I/II/III, Kimbark, Wiley Publication
3. Electrical Power Systems, Ashfaq Hussain, CBS publishers, New Delhi V edition
4. Electric Power Systems: A first course, Ned Mohan, Wiley Publication
5. Power System Operation & Control, K. Uma Rao, Wiley Publication

Term work:

Minimum 8 experiments/simulations based on above curriculum should be performed.

4. CONTROL SYSTEM II

Teaching Scheme	Examination Scheme
Lectures: 04 hrs/week	Theory : 100 marks
Practical: 02 hrs/week	Term Work: 25 marks

Unit-1 Basics of Control Systems

Feedback control system characteristics, Objectives, Different types of controllers, P,I,D, PI, PD and PID Controllers, Effects of these controllers on system performance, Tuning of controllers, Ziegler-Nichols methods for controller tuning, Modifications of PID control scheme.   (06)

Unit-2 Control System Design & Analysis by Root Locus method

Review of Root Locus, Cascade Lead compensation, cascade Lag compensation, cascade Lead-Lag compensation, Series and parallel compensation, Effect of addition of poles and zeros, Design of Lead compensation based on Root Locus approach, Design of Lag compensation based on Root Locus approach, Design of Lead-Lag compensation based on Root Locus approach, Root Locus of system with dead time.   (10)

Unit-3 Control System Design & Analysis by Bode Plot method

Review of Bode Plot, Stability of system from Bode Plot, Cascade Lead compensation, cascade Lag compensation, cascade Lead-Lag compensation, Design of Lead compensation based on Bode Plot, Design of Lag compensation based on Bode Plot, Design of Lead-Lag compensation based on Bode Plot.   (08)

Unit-4 State Space Design using pole placement

Review of State Space, Controllability, Observability (Kalmans's test & Gilbert's test), Pole placement technique for controller design, State Feedback Law, Pole placement technique by Transformation method, Direct Substitution Method and by Ackermann's formula.   (08)

Unit-5 State Space Design using State Observer

State Observers, Full Order State Observer, Transformation Approach to Obtain Observer gain Matrix, Direct Substitution Approach to Obtain Observer gain Matrix, Ackermann's formula to Obtain Observer gain Matrix, Effect of addition of Observer on a Closed Loop System, transfer function of Observer based Controller, Design of Control System with Observer.   (08)

Unit-6 Digital and Advanced Control Systems

Introduction, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equation, The Z-transform, The Z- Transfer Function, The Z-transform Analysis of Sampled Data Control System, Z and S domain Relationship.   (08)

Text books:

1.   Control system: Principles and Design, M. Gopal, Tata Mc Graw-Hill Publication

2.   Modern Control Engineering, K. Ogata, Eastern Economy, 5th edition 2011.

3. Control System Engineering, I. J. Nagrath and M. Gopal, New Age publication, 5th edition, 2008.

Reference books:

1. Automatic Control System, B. C.Kuo, Wiley Publication 8th edition.
2. Control System Engineering, Norman S. Nise, John wiley and Sons, 6th edition, 2014.
3. Digital Control and State Variable Methods, M.Gopal, Tata Mc Graw Hill, 3rd edition
4. Control System Engineering, Gupta, Wiley Publications
5. Control Engineering, K. P. Ramchandran, Wiley Publications
6. Automatic Control Systems, Shridhar, Wiley Publications

Term work:

Minimum 8 experiments/simulations based on above curriculum should be performed.

5.SIGNALS AND SYSTEMS

Teaching Scheme   **Examination Scheme**
Lectures: 03 hrs/week   Theory : 100 marks
Tutorial: 01 hr/week   Term Work: 25 marks

Unit-1 Introduction to signals & systems

Continuous & discrete signal: size of signal, signal operations, classification of signals, standard test signals, singularity functions. Continuous & discrete systems: Classification of systems, system models of Electrical systems   (06)

Unit-2 Description and analysis of system

Continuous & discrete systems: zero state response, zero input response, convolution sum and convolution integral, graphical representation of convolution, block diagram representation of differential and difference equation, FIR and IIR systems   (06)

Unit-3 System Analysis using Laplace transform

Laplace transform: A brief introduction to Laplace transform its properties and inverse Laplace transform, transfer function analysis, solution of LTI differential equation.   (04)

Unit-4 System analysis using Z-transform

A brief introduction to Z–transform, its properties & inverse – Z transform, connection between Laplace transform and Z–transform, transfer function analysis, solution of LTI difference equation, and stability in Z-domain.   (04)

Unit-5 Fourier analysis of continuous signals

Periodic representation by trigonometric Fourier series, Fourier spectrum, Dirichlet's condition, exponential Fourier series, exponential Fourier spectra, Parseval's theorem, Fourier transform and its properties, Relation between Fourier and Laplace Transform, Fourier spectrum   (05)

Unit-6 Fourier analysis of discrete signal

A brief introduction to discrete Fourier series, D.T.F.T., properties of D.T. F. T., relation between DTFT & Z-transform, DTFT spectrum   (06)

Unit-7 Sampling, corleation and spectral density

Sampling methods, representing CT signals by samples, sampling DT signals, correlation and Fourier series, energy and power spectral density of signals   (05)

Text books:
1. Linear systems and signals, B. P. Lathi, Oxford University Press, 2nd edition, 2005
2. Signals and systems, Simon Haykin, Wiley Publications

Reference books:
1. Signals and systems, M. J. Roberts, Tata Mc Graw Hill publications
2. Signals and systems, C. T. Chen, Oxford Publications, 3rd edition, 2004

3. Analog Signal Processing: Analysis & Synthesis, Alok Barua, Wiley Publications

4. Signals & Linear Systems, Gabel, Wiley Publications, 3rd edition

5. Signals and Systems, Krishnaveni, Wiley Publications

Term work:

Minimum 6 assignments based on above curriculum should be submitted by a student as a part of term work.

6. SOFTWARE TOOLS FOR ELECTRICAL ENGINEERS

Teaching Scheme

Practical: 02 hrs/week

Examination Scheme

Term Work: 75 marks

Students are expected to solve Electrical Engineering problems using any available software tools such as MATLAB/Simulink, C, C++, PSIM, ETAP, PSCAD, MIPOWER, Power World Simulator, SKM Power Tools, VISIO, AUTOCAD, PSPICE, LABVIEW etc. Sample tasks are enlisted below. Minimum 12 tasks should be performed as a part of term work.

1. Programming of at least 3 numerical methods for solving nonlinear equations.
2. Simulation of Electrical Machines such as transformers, DC machines and AC machines and evaluation of their performance parameters.
3. Simulation of electrical R-L-C networks, resonant circuits, filter circuits and plotting their input-output waveforms
4. Simulation of power system networks and its performance analysis (load flow analysis, short circuit analysis, transient analysis, stability analysis, relay coordination etc)
5. Simulation of DC-DC, DC-AC, AC-DC and AC-AC converter circuits, plotting their input output waveforms and performing their analysis
6. Measurement techniques for electrical engineering parameters using suitable software
7. Design of typical control panel for industrial applications

SEMESTER-VI

1. ADVANCED ELECTRICAL MEASUREMENTS

Teaching Scheme   **Examination Scheme**
Lectures: 04 hrs/week   Theory : 100 marks
                                                            Term Work: 25 marks

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Unit 1:

Measuring Instruments: Introduction, output power meters, Phase meter, Q meter, LCR meter, Transistor tester, Stroboscope. Measurement of Power: Introduction, Bolometer, Bolometer Element, Mount, Bolometer Bridge, Calorimetric. Measurement of standing wave ratio measurement. (10)

Unit 2:

Passive Transducers: Inductive transducers- Inductive thickness transducers, Inductive displacement transducers, Movable core-type Inductive transducers, eddy current type Inductive transducers. Capacitive transducers- Capacitive thickness transducers, capacitive displacement transducers, capacitive moisture transducers. (06)

Unit 3:

Active Electrical Transducers: Introduction, thermoelectric transducers, thermoelectric phenomenon, common thermocouple systems, piezoelectric transducers, piezoelectric phenomenon piezoelectric materials, piezoelectric force transducers, piezoelectric strain, piezoelectric torque transducers, piezoelectric pressure transducers, piezoelectric acceleration transducers. Magnetostrictive transducers- Magnetostrictive force transducers, Magnetostrictive acceleration transducers, Magnetostrictive torsion transducers, Hall Effect transducers, and application of Hall transducer. (08)

Unit 4:

Electromechanical transducers-Tachometers, variable reluctance tachometers Electrodynamic vibration transducers, Electromagnetic pressure electromagnetic flowmeter. Photoelectric transducers- photoelectric phenomenon, photoelectric transducers, Photo volatile transducers, Photo emissive transducers. Ionization transducers- Ionization vacuum gauges, Ionization displacement transducers, nuclear radiation transducers, radioactive vacuum gauge, radioactive thickness gauge, radioactive level gauges. (08)

Unit 5:

Digital transducers- Digital displacement transducers, Digital tachometers, transducer oscillators. Electrochemical transducers- basics of electrode potentials, reference electrodes, indicator electrodes, measurement of PH, measurement of bioelectric signals. (04)

Unit 6:

Virtual Instrumentation: Graphical System Design, Design flow with GSD, Virtual instruments and Traditional Instruments, Hardware and software in VI, VI for test, control &design, VI in the engineering process, GSD using LabView.Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques, Data acquisition interface requirements –Issues involved in selection of Data acquisition cardsand buses   (08)

Text Books:

1. Instrumentation: Measurement and Analysis, Nakra & Chaudhari, Tata McGraw Hill, New Delhi, 3rd edition
2. Electronic Instrumentation, H. S. Kalsi, McGraw Hill Eduction (India), , 3rd edition
3. Instrumentation Devices and Systems, Rangan, Sarma and Mani, McGraw Hill Eduction (India) 2nd edition.

Reference Books:

1. Electrical Measurement & Measuring Instruments, E. W. Golding & Widdies, A. H. Wheeler & Co. Ltd., Fifth edition
2. A Course in Electrical and Electronic measurements & Instrumentation, A. K. Sawhney, Dhanpat Rai & Sons.
3. Electronic Instruments & Measurement Techniques, W.D. Cooper, Prentice Hall International.
4. Virtual Instrumentation Using LabVIEW by jovitha Jerome, PHI Publications (January 2010)
5. Virtual Instrumentation Using LabVIEW by Sanjay Gupta, Tata McGraw Hill, 2nd Edition (2010)
6. Fundamentals of Industrial Instrumentation, Alok Barua, Wiley Publications

Term work:

Minimum 8 assignments based on above curriculum should be performed.

2. COMMUNICATION ENGINEERING

Teaching Scheme	**Examination Scheme**
Lectures: 03 hrs/week	Theory : 100 marks
Practical: 02 hrs/week	Term Work: 25 marks

SECTION I

Unit 1. Analysis and Transmission of Signals (09Hrs.)
Overview of electrical communication, Size of a signal, classification of signals, signal operations, unit impulse function, signals and vectors, correlation, orthogonal signal sets, Fourier series. Fourier transform, signal transmission through a linear system, ideal and practical filters, signal distortion over a communication channel, signal energy, signal power, numerical computation of Fourier transform.

Unit 2. Amplitude Modulation: (05 Hrs.)
 Base-band and carrier communication, amplitude modulation -DSB, AM, AM, SSB,VSB, carrier acquisition , super heterodyne AM receiver, television.

Unit 4. Angle Modulation: (04 Hrs.)
Concept of instantaneous frequency, band-width of angle modulated waves, generation of FM waves, demodulation of FM, Interference in angle modulated systems, FM receiver.

SECTION II

Unit 4. Sampling and Pulse Code Modulation: (04 Hrs.)
Sampling theorem, pulse-code modulation, differential pulse code modulation, delta modulation.

Unit 5. Digital Data Transmission: (06 Hrs.) Basic digital communication system, line coding, pulse shaping, scrambler, regenerative repeater, detection-error probability, M-array communication, digital carrier systems digital multiplexing.

Unit 6. Information theory and coding (08 Hrs.)
 Cellular telephone, spread spectrum systems, transmission media, public, switched telephone network.Measure of information, source encoding error free communication over a noisy channel, channel capacity of a discrete memory less channel, practical, communication systems in light of Shanon's equation, linear block codes.

Term Work: Minimum 08 experiments to be performed from the following List.
1. Study of AM Transmitter
2. Study of FM Transmitter
3. Study of Digital Transmitter
 4. Study of AM modulation.
5 Study of FM modulation
6 Study of angle modulation
 7 Study of PCM modulation
 8 Study of different types Receivers
9. Two Experiments using MATLAB.

 Reference Books:
1. Modern Digital and Analog Communication systems B.P. Lathi, 3rd Edition, Oxford University Press 1998.
 2. Communication Electronics, L.F. Frangel, Tata McGraw Hill 2002
3. Contemporary Communication systems using MATLAB, J.G. Proakis, Salahi

3. ELECTRICAL MACHINE DESIGN

Teaching Scheme	**Examination Scheme**
Lectures: 03 hrs/week	Theory : 100 marks
Tutorials : 01 hrs/week	Term Work: 50 marks
Practical: 02 hrs/week	POE: 50 marks

Unit 1 : General

i)Materials – Different types of materials used in construction of electrical machines. Conductors: copper and aluminum conductors, properties and applications, standard conductor sizes, copper space factor. Insulating materials: classification, basic properties of common insulating materials, latest developments, insulation thickness and rated voltage, space factor, testing of insulating materials. Magnetic materials: different types of magnetic materials, Characteristics and magnetization curves, iron losses, basis of selection for particular application.

ii)Heating, Cooling and ventilation – Types of enclosures, Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants, calculation of short time and continuous rating of electrical machine. Temp. rise and rating of machines. Cooling medium used; oil, hydrogen and water. (08)

Unit 2 :Basic Design principles

General consideration in the design, limitations in the design, Output coefficient and their standard values for various machines, effect of size & ventilation on specific electric and magnetic loading. Different Indian Standard Specifications (ISS).

i) Magnetic circuits – Formulae for air and iron parts, calculations for magnetic circuits of electric machines, estimation of no load current, determination of leakage fluxes and reactance calculations, design of electromagnets.

ii) Mechanical Design – design of shafts, choice and types of bearings, determination of mechanical strength of rotors, design consideration of cooling fans and frames. (06)

Unit 3 :Design of Transformers

Classification of transformer (Core type, Shell type transformer), Comparison of core and Shell type transformer, Single phase & 3 Phase transformer connections, Core Cross Section, Cooling of transformer, transformer Insulation using Oil & other materials

Output equation of transformer, Relation between Core Area & Weight of iron & copper, Design for minimum cost, Design for minimum loss or maximum efficiency, variation of Output & losses in transformer with linear Dimensions, Design of Core (rectangular core, Square & stepped Cores), Variation of Core Diameter, Selection of core areas & type of core, Choice of Flux Density, design of winding, Windows Space Factor, Windows Dimensions, Overall Dimensions, Simplified Steps for transformer Design. Resistance of Winding, Mechanical Forces, No load currents, No load current of 1ph transformer, No load current of 3ph transformer, Design of Tank with Tubes, Core Design, Winding Design, Window Area. (08)

Unit 4: Design of DC Machines

Introduction & Applications, classification, Constructional Details, Stator, Armature, Commutator, Brush Gear, Design output Equation, Interdependence of specific & Electric loadings, Selection of no of poles, Core Length, Armature diameter, Length of air gap, No of Armature coils, No of Armature Slots, Cross Section of Armature Conductors, Insulation of armature winding, Slots Dimensions, Poles Design (Area of poles, Height of Poles), length of Inter poles, Losses & Efficiency (Rotational Losses, I^2r Losses Stray load losses, Efficiency). Design of commutator and brush gear. (06)

Unit 5: Design of AC Machines

i) Design of 3 Phase Induction Motor : Main Dimension, stator Winding,(Turns Per Phase, Stator Conductors), Shapes Of Stator Slots, No of Stator Slots, Area of stator Slots, Length Of Mean Turn, Stator Teeth, Stator Core, Rotor Design, length of air gap, Relation For Calculations Of Length of air gap, No of Rotor Slots,(Rules For Selecting Rotor Slots, Reduction of Harmonic torques), Design of rotor bars & Slots, (Rotor Bar Currents, Area of Rotor Bar, shapes & Size Of Rotor Slots, Rotor Slot Insulations), Design of End Rings.

ii) Design of Alternators : Output equation, determination of no. of poles, wdg and insulation. Main dimensions, stator and rotor core, slots, conductors, armature wdg, calculation of reactance & armature reaction, voltage regulation. (06)

Unit 6: Design of starters and field regulators

Design of different types of motor starters, field regulators, design of heating coils for various applications. (03)

Text Books:

1. Theory and Performance and Design of A.C. Machines, M.G. Say, ELBS London, 3rd Edition.
2. A Course in Electrical Machine Design, A.K.Sawhney, Dhanpat Rai & sons New Delhi
3. Design of Electrical Machines, K. G. Upadhyay, New age publication.
4. Principles of Electrical Machine Design, R. K. Agarwal, S. K. Katariya and sons.
5. Design of Transformers, Indrajit Dasgupta, TATA Mc-Graw Hill Publication

Reference books:

1. A Text Book of Electrical Engineering Drawings, K.L. Narang, Satya Prakashan, New Delhi.
2. Electrical Machine Design Data Book, A Shanmugasundaram, G. Gangadharan, R. Palani, 3rd Edition, Wiely Eastern Ltd., New Delhi
3. Computer Aided Design for Electrical Machines, Vishnu Murthy, B.S. Publications.
4. Transformers, Bharat Heavy Electricals Limited, Tata Mc-Graw Hill publications.

Term work:

The term work shall consist of Four drawing sheets (Minimum Two sheets should be drawn using suitable software).

1. Details and assembly of 3-phase transformer with design report.
2. Assembly of D.C. Machine.
3. Details and layout of AC winding with design report.
4. Assembly of 3- phase Alternator.
5. Assembly of 3- phase induction motor.(only sheet)
6. Report based on Industrial visit to a manufacturing unit. (Transformer or Induction motor).

4. POWER SYSTEMS-III

Teaching Scheme
Lectures: 04 hrs/week
Practical: 02 hrs/week

Examination Scheme
Theory : 100 marks
Term Work: 25 marks

Unit 1: Introduction to Power System Stability & Control

Power System Stability, Classification Power system Stability, State Operation & System Security :-Review, System Dynamics Problems Current Status & Recent Trends, System Model, Dynamics of Synchronous Machine [Swing equation] NUMERICALS EXPECTED (06)

Unit 2: Power system Stability

Factors affecting Transient Stability, Swing Equation Solution [Point By Point Method, Equal Area Criteria], Transient Stability Limit, Critical Clearing Angle and Critical Fault Clearing Time, Fault Shunts and Impedances of Fault Shunts, Multi Machine Stability, NUMERICALS EXPECTED. (10)

Unit 3: Methods of Improving Stability

Transient Stability Enhancements:- High Speed Fault clearing, Reduction of transmission system reactance , regulated shunt compensation , dynamic Braking , Reactor Switching, Controlled system Separation & Load Shedding – High Speed Excitation & Control, Discontinuous Excitation Control, Small Signal Stability Enhancement-Power system Stabilizers, Supplementary Control of SVC (10)

Unit 4: Power System Control

Automatic Generation Control, Load Frequency Control (Single Area & Two Area Case), Automatic Voltage Control, Reactive Power Control, NUMERICALS EXPECTED (10)

Unit 5: Optimal Power System Operation

Load Forecasting, Optimal Unit commitment, Economic load Dispatch [with/without Transmission line Losses & Generator Limits], NUMERICALS EXPECTED (08)

Unit 6: Power System Security

System State Classification, Security Analysis, Contingency Analysis, Sensitivity Factors, Factors Affecting Power System Security. (04)

Text books:
1. Modern Power System Analysis, D. P. Kothari, I. J. Nagrath, Mc-Graw Hill Publications, Fourth Edition 2012
2. Power System Analysis, Hadi Saadat, Tata Mc-Graw Hill
3. Power System Operation and Control, Dr. K Uma Rao, Wiley India Publication

Reference books:
1. Power System Stability and Control, Prabha Kundur, TMH Publications.
2. Computer Modeling of Electrical Power Systems, Arrilaga, Wiley Publications, 2nd edition

3. Power Generation, Operation and Control, Allen J. Wood, Wollenberg, Wiley India 2nd edition
4. Power System Dynamics, K. R. Padiyar, BS Publications, Second Edition
5. Electrical Power Systems, Weedy, Wiley Publications, 5th edition
6. Power System Harmonic Analysis, Arrilaga, Wiley Publications

Term work:

Minimum 8 simulations/assignments based on above curriculum should be performed.

5. ELECTRICAL DRIVES

Teaching Scheme	Examination Scheme
	Theory : 100 marks
Lectures: 04 hrs/week	Term Work: 25 marks
Practical: 02 hrs/week	POE: 50 marks

Unit 1: Introduction

Concept of Electrical drive, Classification of Electrical drives, Parts of Electrical drive, Types of loads and their characteristics, Motor load interaction, Dynamic conditions in Electrical drives, Stability considerations in Electrical drives   (04)

Unit 2: Control of DC motor by Single & Three-Phase Converters

Introduction, review of Classification of dc motors and their speed control, Electric braking of dc motors, Block Diagram of Electrical Drive, Single phase Controlled Converter for Separately Excited dc motor Drives, DC series Motor Drives, Introduction to 4 quadrant operation of dc motor, Single phase Dual Converter for Four Quadrant Operation

Three phase semi converter Fed with Separately Excited dc Motor, Three Phase Full Converter Fed with Separately Excited dc motor, Three phase semi converter Fed dc Series Motor, Three Phase Full- converter Fed dc Series Motor   (08)

Unit 3: Control of DC Motor by Chopper

Introduction, Principle of chopper Operation, Control Techniques Used in dc choppers, Chopper Configuration, Classification of Chopper Circuits (single quadrant and four quadrant operation of chopper), Performance of chopper Fed Separately Excited dc Motors, Introduction to Closed Loop Control of Drives   (06)

Unit 4: Induction Motor Drives: Stator side control

Stator voltage control: Introduction, review of types of 3 phase Induction motors, Torque-speed characteristic of 3 phase Induction motor, Stator Voltage Control using different 3 phase AC voltage controllers, Introduction to closed loop control using stator voltage control, introduction to 4 quadrant AC voltage controllers

Stator Frequency control: Introduction, Variable Frequency Characteristics, Block Diagram of Variable Frequency Speed Control, V/f control, Voltage Source Inverter (VSI) fed induction motor drive, Braking and multi quadrant operation of VSI fed induction motor drive, Variable Frequency Control From a current Source inverter (CSI), comparison of VSI and CSI drives, Introduction of Closed loop speed Control for VSI fed Induction Motor Drives, Basic operation of Pulse Width Modulated Inverter Fed Induction motor Drive   (12)

Unit 5: Induction Motor Drives: Rotor side control

Introduction, Conventional Rotor Resistance Control, Rotor Resistance Control using power converters, Slip Power Recovery Schemes (Static Kramer drive, Static Scherbius drive), Introduction to Vector control of Induction motor   (06)

Unit 6: Synchronous Motor Drives

Introduction, review of synchronous motor types & operation, Speed Control of Synchronous Machines in self control mode and true synchronous mode, Load- commutated Inverter Fed Synchronous Motor Drive, Closed loop Speed control of Synchronous Motor using Load-commutated Inverter, Operation of Voltage Source Inverter Fed Synchronous Motor Drive   (06)

Text books:

1. Power Semiconductor Drives, S. Sivanagaraju, M. B. Reddy, A. M. Prasad, PHI, Delhi
2. Fundamentals of Electrical Drives, G. K. Dubey, CRC Press, II edition
3. Electric Drives, N. K. De, P. K. Sen
4. Electric Drives: Concepts & Applications, Vedam Subrahmanyam, Tata Mc-Graw-Hill

Reference books:

1. Electrical Machines & Drives, A First course, Ned Mohan, Wiley Publications
2. Power Electronics: Converters, Applications & Design, Ned Mohan, Wiley Publications III edition
3. Power Electronics & Variable frequency drives: Technology & applications, Bose, Wiley Publications
4. Power Electronics: Circuits, Devices, and Applications, M. H. Rashid, Prentice Hall, III edition
5. Principles of Electric Machines & Power Electronics, P. C. Sen, Wiley Publications, II edition

Term work:

Minimum 6 experiments and 4 simulations based on above curriculum should be performed.

6. ELECTRICAL WORKSHOP

Teaching Scheme

Practical: 02 hrs/week

Examination Scheme

Term Work : 50 marks

Students are expected to complete at least 6 tasks from the following list. Out of these 6 tasks at least 2 must be of fabrication type. A group of maximum 3 students can be formed for fabrication type tasks.

1. Hands on training of all major tools/accessories/equipments used in electrical laboratories and/or workshop.
2. Preparation of test lamp by the student (single bulb for single phase test and two lamp in series to test three phase supply) and their usage for single and three phase supply. Test line for continuity with test lamp / multimeter.
3. Replacing the old element for heater, kettle, non- automatic electronic iron, room heaters etc., with a new one and testing the appliance to ensure proper functioning and safety against shock.
4. Dismantling and reassembling minimum 4 appliances such as electric iron , heater, kettle, room heater, toaster, hair drier, mixer etc.
5. Installing a ceiling fan along with its regulator.
6. Checking a fluorescent lamp, choke, starter and install the same. (about 5 defective tube-light set are to be provided with different type of faults. Student must be able to identify the fault and troubleshoot the same)
7. Fabrication of PCB as per given layout : a) artwork & printing of a simple PCB b) Etching & drilling of PCB, inserting components, soldering components, testing the assembled circuit.
8. Fabrication of DC regulated power supply.
9. Removal of insulation and fixing of various types of lugs in wire/ cable using crimping tool.
10. Preparation of various types of joints for flexible conductor and ACSR conductor.
11. Fixing of ACSR conductor on various types of insulators.
12. Designing, assembling and testing of rectifier circuits - half wave, full wave & bridge rectifier and testing input/output waveform on oscilloscope.
13. To visit distribution substation and preparing a detailed layout for service connection for industrial installation
14. Visiting nearby leading motor rewinding workshop and observing various repairing and testing activities.

Equivalence

Old Course Title	Revised Course Title
Engineering Mathematics-III	Engg. Maths III
Generation & Its Economics	Electrical Engineering Materials and Energy Conversion
Analog Electronics	Analog Electronic Engineering
Electrical Circuit Analysis	Electromagnetic and Electrical Circuits
Electrical Measurement	Measurements and Instruments
Advanced C - programming	Programming in C
DC Machines and Transformers	DC Machines and Transformer
	Power Electronics
	Power Systems I
	Network Analysis and Synthesis
	Control System I
	Environmental Studies
Introduction to Pspice & MATLAB	Circuit Simulation
Signals and Systems	
A.C. Machines	
Industrial Management and Economics	
Digital Systems and Microprocessors	
Introduction to advanced packages (LABVIEW)	