Course code	Course Name	L-T-P - Credits	Year of Introduction
EE301	POWER GENERATION, TRANSMISSION AND PROTECTION	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To set a foundation on the fundamental concepts of Power System Generation,Transmission, Distribution and Protection.

Syllabus

Power Generation-conventional-hydrothermal, nuclear - non conventional solar and wind-economics of power generation-Power factor Improvement-Power transmission -line parameters -resistance- inductance and capacitance- Transmission line modelling- classifications -short line, medium line, long line-transmission line as two port network-parameters- derivation -Overhead lines- types of conductors-volume of conductors- Kelvin's law- Types of Towers-calculation of Sag and tension-
Insulators- types -corona-underground cables-H V DC transmission-Flexible A C transmission-
-need for protection-circuit breakers-protective relay types -Types of protection causes of over voltages - insulation coordination – Power Distribution system

Expected outcome .

The students will be able to

i. Know the basic aspects in the area of power generation, transmission, distribution and protection.

ii. Design power factor correction equipment, transmission line parameters, and decide upon the various protection schemes to be adopted in various cases.

Text Books:

1. D P Kothari and I Nagrath, "Power System Engineering," 2/e Tata McGraw Hills, 2008
2. Wadhwa, "Electrical Power system", Wiley Eastern Ltd. 2005

References:

1. A.Chakrabarti, ML.Soni, P.V.Gupta, V.S.Bhatnagar, "A text book of Power system Engineering" Dhanpat Rai, 2000
2. Grainer J.J, Stevenson W.D, "Power system Analysis", McGraw Hill
3. I.J.Nagarath & D.P. Kothari, "Power System Engineering", TMH Publication,
4. K.R Padiyar," FACTS Controllers for Transmission and Distribution" New Age International, New Delhi
5. Stevenson Jr. Elements of Power System Analysis, TMH
6. Sunil S Rao ,"Switch gear and Protection",Khanna Publishers

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Introduction: Typical layout of Power system Network** **Generation of Electric Power:** Overview of conventional (Hydro, Thermal and Nuclear) and Nonconventional Sources (Solar and Wind) (Block Diagram and Brief Description Only) **Economics of Generation:** Load factor, diversity factor, Load curve (Brief description only) Numerical Problems. Methods of power factor improvement using capacitors	9	15%
II	**Power Transmission** **Transmission Line Parameters:** Resistance, inductance and capacitance of 1-Φ, 2 wire lines-composite conductors	10	15%

	(Derivation Required). Inductance and capacitance of 3-Φ lines. Symmetrical and unsymmetrical spacing-transposition-double circuit lines-bundled conductors (Derivation Required) .Numerical Problems **Modelling of Transmission Lines**: Classification of lines-short lines-voltage regulation and efficiency-medium lines-nominal T and Π configurations-ABCD constants- long lines- rigorous solution- interpretation of long line equation-Ferranti effect.		
FIRST INTERNAL EXAMINATION			
III	**Introduction of Overhead transmission and underground transmission** Conductors -types of conductors -copper, Aluminium and ACSR conductors -Volume of conductor required for various systems of transmission-Choice of transmission voltage, conductor size -Kelvin's law. Mechanical Characteristics of transmission lines – configuration-Types of Towers. Calculation of sag and tension-supports at equal and unequal heights -effect of wind and ice-sag template Insulators -Different types -Voltage distribution, grading and string efficiency of suspension insulators. Corona -disruptive critical voltage -visual critical voltage -power loss due to corona -Factors affecting corona - interference on communication lines.	9	15%
IV	Underground Cables -types of cables -insulation resistance -voltage stress -grading of cables -capacitance of single core and 3 -core cables -current rating. **HVDC Transmission:** Comparison between AC &DC Transmission ,Power flow equations and control, Types of DC links **Flexible AC Transmission systems**: Need and Benefits, SVC, Configuration of FC + TCR, Series compensation: Configuration of TCSC	8	15%
SECOND INTERNAL EXAMINATION			
V	**Need for power system protection.** **Circuit breakers –** principle of operation- formation of arc-Arc quenching theory- Restriking Voltage-Recovery voltage, RRRV (Derivation Required). Interruption of Capacitive currents and current chopping (Brief Description Only). Types of Circuit Breakers: Air blast CB – Oil CB – SF6 CB – Vacuum CB – CB ratings.		20%

	Protective Relays- Zones of Protection, Essential Qualities-Classification of Relays -Electro mechanical, Static Relays, Microprocessor Based Relay. Electromechanical Relays-Attracted Armature, Induction disc, Thermal Relays (Brief Description only) Static Relays-Merits and Demerits, Basic components, Comparison and duality of Amplitude and Phase comparators. Static overcurrent, Differential, Distance Relays, Directional Relay-(principle and Block diagram only) Microprocessor Based Relay-Block diagram and flow chart of Over current Relay, Numerical Relay(Basics Only)	10	
VI	**Protection of alternator:** Stator inter turn, Earth fault Protection and Differential protection **Protection of transformers-** Percentage Differential Protection-Buchholz Relay **Protection of transmission lines-**Differential Protection-carrier current protection **Protection against over voltages**: Causes of over voltages - Surge diverters - Insulation co-ordination **Power distribution systems –**Radial and Ring Main Systems - DC and AC distribution: Types of distributors- bus bar arrangement -Concentrated and Uniform loading -Methods of solving distribution problems.	10	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE302	ELECTROMAGNETICS	2-1-0-3	2016

Prerequisite: Nil

Course Objectives

- To develop a conceptual basis of electrostatics, magnetostatics, electromagnetic waves
- To understand various engineering applications of electromagnetics

Syllabus

Introduction to vector calculus, Electrostatics, Electrical potential, energy density and their applications. Magneto statics, magnetic flux density, scalar and vector potential and its applications, Time varying electric and magnetic fields, Electromagnetic waves

Expected outcome .

The students will be able to:

i. Analyze fields and potentials due to static charges
ii. Explain the physical meaning of the differential equations for electrostatic and magnetic fields
iii. Understand how materials are affected by electric and magnetic fields
iv. Understand the relation between the fields under time varying situations
v. Understand principles of propagation of uniform plane waves.
vi. Be aware of electromagnetic interference and compatibility

Text Book:

1. Nannapeni Narayana Rao, "Elements of Engineering Electromagnetics", Prentice Hall India
2. Sadiku M. N. O, *Elements of Electromagnetics*, Oxford university Press, 2010

Data Book (Approved for use in the examination):

References:

1. Cheng D. K., Field and Wave Electromagnetic, Pearson Education, 2013.
2. Edminister J. A., Electromagnetics, Schaum Outline Series , Tata McGraw-Hill, 2006.
3. Gangadhar K. A. and P. M. Ramanathan , Electromagnetic field theory , Khanna Publishers, 2009.
4. Hayt W. H. and J. A. Buck , Engineering Electromagnetics, 8/e, McGraw-Hill, 2012.
5. Inan U. S. and A. S. Inan, Engineering Electromagnetics, Pearson Education, 2010.
6. John Krauss and Daniel A. Fleisch, Electromagnetics with Applications, McGraw-Hill, 5th edition
7. Murthy T. V. S. A, Electromagnetic field, S. Chand Ltd, 2008.
8. Premlet B., Electromagnetic theory with applications, Phasor Books, 2000.
9. S.C.Mahapatra and Sudipta Mahapatra ,Principles of Electromagnetics, McGraw-Hill, 2015

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**STATIC ELECTRIC FIELDS:** Introduction to Co-ordinate System – Rectangular – Cylindrical and Spherical Co- ordinate System – Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field- Their Physical interpretation. Divergence Theorem, Stokes' Theorem. Numerical problems	6	15%
II	Coulomb's Law, Electric field intensity. Field due to a line charge, Sheet Charge and Continuous Volume Charge distribution. Electric Flux and Flux Density; Gauss's law and its application. Electric Potential-The Potential Gradient. The Electric dipole. The Equipotential surfaces. Capacitance - capacitance of co-axial cable, two wire line. Poisson's and Laplace's equations	8	15%
FIRST INTERNAL EXAMINATION			

III	STATIC MAGNETIC FIELD: Biot-Savart Law, Amperes Force Law.– Magnetic Field intensity due to a finite and infinite wire carrying a current–Magnetic field intensity on the axis of a circular and rectangular loop carrying a current –Magnetic vector potential, Magnetic flux Density and Ampere's circuital law and simple applications.	6	15%
IV	ELECTRIC AND MAGNETIC FIELDS IN MATERIALS–Electric Polarization-Nature of dielectric materials-Electrostatic energy and energy density–Boundary conditions for electric fields and magnetic fields–Conduction current and displacement current densities–continuity equation for current. Maxwell's Equation in Differential and integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss Law	8	15%
SECOND INTERNAL EXAMINATION			
V	TIME VARYING ELECTRIC AND MAGNETIC FIELDS:. Poynting Vector and Poynting Theorem – Power flow in a co-axial cable – Complex Average Poynting Vector. ELECTROMAGNETIC WAVES: Wave Equation from Maxwell's Equation – Uniform Plane Waves –Wave equation in Phasor form	7	20%
VI	Plane waves propagation in loss less and lossy dielectric medium and conducting medium. Plane wave in good conductor, surface resistance, Skin depth, Intrinsic Impedance and Propagation Constant in all medium. Phase and group velocity. Transmission lines: waves in transmission line –solution for loss less lines –characteristic impedance – VSWR – impedance matching. Introduction to Electromagnetic interference and compatibility.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE303	Linear Control Systems	2-1-0-3	2016

Prerequisite: Nil

Course Objectives:

- To provide a strong foundation on the analytical and design techniques on classical control theory and modelling of dynamic systems

Syllabus :

Open loop-and closed loop control systems- Transfer function - Control system components-Steady stare error- static error coefficient- dynamic error coefficient-Stability Analysis- Root locus- Frequency domain analysis-Bode plot-polar plot-Nyquist stability criterion- Non-minimum phase system - transportation lag.

Expected outcome.

The students will have the ability to

i. develop mathematical models of various systems.
ii. analyse the stability aspects of linear time invariant systems.

Text Books:

1) Dorf R. C. and R. H. Bishop, Modern Control Systems, Pearson Education, 2011.
2) Nagarath I. J. and Gopal M., Control System Engineering, Wiley Eastern, 2008.
3) Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern, 2010.
4) Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010.

References:

1) Gibson J. E., F. B. Tuteur and J. R. Ragazzini, Control System Components, Tata McGraw Hill, 2013
2) Gopal M., Control Systems Principles and Design, Tata McGraw Hill, 2008.
3) Imthias Ahamed T P, *Control Systems*, Phasor Books, 2016
4) Kuo B. C., Automatic Control Systems, Prentice Hall of India, New Delhi, 2002.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Open loop-and closed loop control systems: Transfer function of LTI systems-Mechanical and Electromechanical systems – Force voltage and force current analogy - block diagram representation - block diagram reduction - signal flow graph - Mason's gain formula - characteristic equation.	8	15%
II	Control system components: DC and AC servo motors – synchro - gyroscope - stepper motor - Tacho generator. Time domain analysis of control systems: Transient and steady state responses - time domain specifications - first and second order systems - step responses of first and second order systems.	6	15%
	FIRST INTERNAL EXAMINATION		
III	Error analysis - steady state error analysis - static error coefficient of type 0,1, 2 systems - Dynamic error coefficients. Concept of stability: Time response for various pole locations - stability of feedback system - Routh's stability criterion	7	15%
IV	Root locus - General rules for constructing Root loci – stability from root loci - effect of addition of poles and zeros.	7	15%
	SECOND INTERNAL EXAMINATION		
V	Frequency domain analysis: Frequency domain specifications- Analysis based on Bode plot - Log magnitude vs. phase plot,	7	20%

VI	Polar plot- Nyquist stability criterion-Nichols chart - Non-minimum phase system - transportation lag.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE304	Advanced Control Theory	3-1-0-4	2016

Prerequisite: EE303 Linear control systems

Course Objectives:

- To provide a strong concept on the compensator design and on advanced control system analysis and design techniques
- To analyse the behaviour of discrete time systems and nonlinear control systems.

Syllabus:

Compensator design-Frequency domain approach-root locus method-Tuning of P, PI and PID controller-State space analysis of systems-state feedback controller design-sampled data control systems-Nonlinear systems-describing function-phase plane-Lyapunov method.

Expected outcome.

On successful completion, students will have the ability to

i. design compensators using classical techniques.
ii. analyse both linear and nonlinear system using state space methods.
iii. analyse the stability of discrete system and nonlinear system.

Text Book:

1. Hassan K Khalil, Nonlinear Systems, Prentice - Hall International (UK), 2002.
2. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications.
3. Nagarath I. J. and Gopal M., Control System Engineering, Wiley Eastern, 2008.
4. Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern, 2010.
5. Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010.

Data Book (Approved for use in the examination):

References:

1. Alberto Isidori, Nonlinear Control Systems, Springer Verlag, 1995.
2. Gibson J. E., F.B. Tuteur and J. R. Ragazzini, Control System Components, Tata McGraw Hill, 2013
3. Gopal M., Control Systems Principles and Design, Tata McGraw Hill, 2008.
4. Jean-Jacques E. Slotine & Weiping Li, Applied Nonlinear Control, Prentice-Hall., NJ, 1991.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Types of controller- Feedforward-feedback-cascade-P, PI and PID. Compensator design: Realization of compensators – lag, lead and lag-lead -Design of compensator using bode plot.	7	15%
II	Compensator design: Realization of compensators – lag, lead and lag-lead. Design of compensator using rootlocus. Design of P, PI and PID controller using Ziegler-Nichols tuning method.	7	15%
	FIRST INTERNAL EXAMINATION		
III	State space analysis of systems: Introduction to state concept - state equation of linear continuous time systems, matrix representation of state equations. Phase variable and canonical forms of state representation-controllable, observable, diagonal	7	15%

	and Jordan canonical forms- solution of time invariant autonomous systems, forced system-state transition matrix-relationship between state equations and transfer function. Properties of state transition matrix-Computation of state transition matrix using Laplace transform-Cayley-Hamilton method. Conversion from canonical form to phase variable form.		
IV	State feedback controller design: Controllability & observability. State feed-back design via pole placement technique. Sampled data control system: Pulse Transfer function-Stability of sampled data system -Routh Hurwitz criterion and Jury's test. Introduction to state-space representation of sampled data systems.	7	15%
SECOND INTERNAL EXAMINATION			
V	Nonlinear systems: Introduction - characteristics of nonlinear systems. Types of nonlinearities. Analysis through harmonic linearisation - Determination of describing function of nonlinearities (relay, dead zone and saturation only) - application of describing function for stability analysis of autonomous system with single nonlinearity.	7 hrs	20%
VI	Phase Plane Analysis: Concepts- Construction of phase trajectories for nonlinear systems and linear systems with static nonlinearities - Singular points – Classification of singular points. Definition of stability- asymptotic stability and instability Liapunov methods to stability of linear and nonlinear, continuous time systems.	7 hrs	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE305	Power Electronics	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To get an overview of different types of power semiconductor devices and their switching characteristics
- To study the operation and characteristics of various types of power electronic converters

Syllabus :

Structure and characteristics of various power semiconductor devices – turn-on methods – controlled rectifiers – inverters – AC voltage controllers – cycloconverters – DC choppers and switching regulators

Expected outcome.

The students who successfully complete this course will be able to:

i. Choose appropriate power semiconductor device in converter circuits and develop their triggering circuits.
ii. Analyze various types of power electronic converters and apply different switching techniques.
iii. Select appropriate power converter for specific applications.
iv. Interpret and use datasheets of power semiconductor devices for design.

Text Book:

Muhammad H. Rashid, *Power Electronics Circuits, Devices and Applications*, Pearson Education

References:

1. Mohan N., T. M. Undeland and W. P. Robbins., Power Electronics, Converters, Applications & Design, Wiley-India
2. Krein P. T., Elements of Power Electronics, Oxford University Press, 1998.
3. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi
4. L. Umanand, Power Electronics – Essentials & Applications, Wiley-India
5. Singh M. D. and K. B. Khanchandani, *Power Electronics*, Tata McGraw Hill, New Delhi, 2008.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	SCR-Structure, static characteristics & switching (turn-on & turn-off) characteristics - di/dt & dv/dt protection – turn-on methods of SCR - two transistor analogy - series and parallel connection of SCRs Structure and principle of operation of power diode, TRIAC, GTO, Power MOSFET & IGBT – Comparison	6	15%
II	**Gate triggering circuits** – R, RC, UJT triggering circuits – natural and forced commutation (concept only). Requirements of isolation and synchronisation in gate drive circuits- Opto and pulse transformer based isolation. **Controlled rectifiers** – half-wave controlled rectifier with R load – 1-phase fully controlled bridge rectifier with R, RL and RLE loads (continuous & discontinuous conduction) – output voltage	8	15%

	equation – 1-phase half controlled bridge rectifier with R, RL and RLE loads – displacement power factor – distortion factor.		
FIRST INTERNAL EXAMINATION			
III	3-phase half-wave controlled rectifier with R load – 3-phase fully controlled & half-controlled converter with RLE load (continuous conduction, ripple free) – output voltage equation-waveforms for various triggering angles (no analysis) – 1-phase & 3-phase dual converter with & without circulating current – four-quadrant operation	7	15%
IV	**Inverters** – voltage source inverters– 1-phase half-bridge & full bridge inverter with R & RL loads – THD in output voltage – 3-phase bridge inverter with R load – 120° & 180° conduction mode – current source inverters.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Voltage control in inverters** – Pulse Width Modulation – single pulse width, multiple pulse width & sine PWM – modulation index & frequency modulation ratio. **AC voltage controllers** (ACVC) – 1-phase full-wave ACVC with R, & RL loads – waveforms – RMS output voltage, input power factor with R load – sequence control (two stage) with R load	7	20%
VI	**DC-DC converters** – step down and step up choppers – single-quadrant, two-quadrant & four quadrant chopper – pulse width modulation & current limit control in dc-dc converters. Switching regulators – buck, boost & buck-boost - continuous conduction mode only – waveforms – design of filter inductance & capacitance	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE306	POWER SYSTEM ANALYSIS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To enable the students to analyse power systems under normal and abnormal conditions.
- To understand the need for load flow analysis and different methods
- To understand power system modeling
- To understand the need for stability studies and their analysis

Syllabus

Per unit quantities - modeling of power system components - methods of analyzing faults in symmetrical and unsymmetrical case - load flow studies - Automatic Generation Control - Automatic voltage control – Economic load dispatch - Unit commitment - Power system stability - Solution of swing equation - Methods of improving stability limits

Expected outcome .

The students will be able to:

i. Analyse power systems under normal and abnormal conditions.
ii. Carry out load flow studies under normal and abnormal conditions

References:

1. Cotton H. and H. Barber, Transmission & Distribution of Electrical Energy, 3/e, Hodder and Stoughton, 1978.
2. Gupta B. R., *Power System Analysis and Design*, S. Chand, New Delhi, 2006.
3. Gupta J.B., Transmission *& Distribution of Electrical Power*, S.K. Kataria & Sons, 2009.
4. Hadi Saadat, *Power System Analysis*, 2/e, McGraw Hill, 2002.
5. Kothari D. P. and I. J. Nagrath, *Modern Power System Analysis*, 2/e, TMH, 2009.
6. Kundur P., *Power system Stability and Control*, McGraw Hill, 199
7. Soni, M.L., P. V. Gupta and U. S. Bhatnagar, *A Course in Electrical Power*, Dhanpat Rai & Sons, New Delhi, 1984.
8. Stevenson W. D., *Elements of Power System Analysis*, 4/e, McGraw Hill, 1982.
9. Uppal S. L. and S. Rao, *Electrical Power Systems*, Khanna Publishers, 2009.
10. Wadhwa C. L., *Electrical Power Systems*, 33/e, New Age International, 2004.
11. Weedy B. M., B. J. Cory, N. Jenkins, J. B. Ekanayake and G. Strbac, *Electric Power System*, John Wiley & Sons, 2012.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Per unit quantities-single phase and three phase-selection of base quantities -advantages of per unit system –changing the base of per unit quantities-Simple problems.	2	15%
	Modelling of power system components - single line diagram – per unit quantities. Symmetrical components- sequence impedances and sequence networks of generators, transformers and transmission lines.	3	
II	Methods of analyzing faults in symmetrical and unsymmetrical case- effects of faults - Power system faults - symmetrical faults - short circuit MVA - current limiting reactors-	8	15%

	Unsymmetrical faults - single line to ground, line to line, double line to ground faults -consideration of prefault current-problems.		
FIRST INTERNAL EXAMINATION			
III	Load flow studies – Introduction-types-network model formulation - formation of bus impedance and admittance matrix, Gauss-Siedel (two iterations), Newton-Raphson (Qualitative analysis only) and Fast Decoupled method (two iterations) - principle of DC load flow.	8	15%
IV	Automatic Generation Control: Load frequency control: single area and two area systems - Automatic voltage control.	6	15%
SECOND INTERNAL EXAMINATION			
V	Economic Operation - Distribution of load between units within a plant - transmission loss as a function of plant generation - distribution of load between plants - Method of computing penalty factors and loss coefficients.	5	20%
	Unit commitment: Introduction — Constraints on unit commitments: Spinning reserve, Thermal unit constraints-Hydro constraints. -	2	
VI	Power system stability - steady state, dynamic and transient stability-power angle curve-steady state stability limit	3	20%
	Mechanics of angular motion-Swing equation – Solution of swing equation - Point by Point method - RK method - Equal area criterion application - Methods of improving stability limits.	5	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE307	SIGNAL AND SYSTEMS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart knowledge about the representation and properties of signal and systems and applications in engineering

Syllabus:

Classification of signals - Basic operations on signals- properties of systems- Convolution- Laplace transform-applications-Fourier series and Fourier transforms- properties- Discrete time systems-sampling- ZT-properties-applications- DFS-DFT-properties-Basics of Nonlinear systems

Expected Outcome:

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

i. Represent various signals and systems
ii. Analyse the continuous time system with Laplace transform
iii. Represent and analyse signals using Fourier representation
iv. Analyse the discrete time system using ZT
v. Analyse the DT systems with DFS
vi. Acquire basic knowledge in nonlinear systems

Text books:

1. Haykin S. & Veen B.V., Signals & Systems, John Wiley
2. Oppenheim A.V., Willsky A.S. & Nawab S.H., Signals and Systems, Tata McGraw Hill
3. Signals and Systems: I J Nagrarth- Tata McGraw Hill

References:

1. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill
2. Farooq Husain , Signals and Systems, Umesh pub.
3. Papoulis A., Fourier Integral & Its Applications, McGraw Hill
4. Taylor F.H., Principles of Signals & Systems, McGraw Hill

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to signals and systems - Classification of signals - Basic operations on signals – Elementary signals – Concept of system - Properties of systems - Stability, inevitability- time invariance- Linearity -Causality – Memory- Convolution- Impulse response- Representation of LTI systems - Differential equation representations of LTI systems	7	15%
II	Laplace transform analysis of systems - Relation between the transfer function and differential equation –Causality and stability - Inverse system - Determining the time domain and frequency response from poles and zeros	7	15%
	FIRST INTERNAL EXAMINATION		
III	Fourier representation of continuous time signals –Fourier	7	15%

	Series-Harmonic analysis of common signals- Fourier transform - Existence –properties of FT- Energy spectral density and power spectral density - Frequency response of LTI systems -		
IV	Sampled data systems- Sampling process-sampling theorem-signal re construction- Zero order and First order hold circuits- Difference equation representations of LTI systems - Discrete form of special functions- Discrete convolution and its properties	7	15%
SECOND INTERNAL EXAMINATION			
V	Z Transform - Region of convergence- Properties of the Z transform – Inverse ZT-methods Z-transfer function- Analysis of difference equation of LTI systems – Basic idea on Stability and causality conditions-	7	20%
VI	Fourier representation of discrete time signals - Discrete Fourier series–properties- Frequency response of simple DT systems Basics of Non linear systems-types and properties Introduction to random signals and processes (concepts only)	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
EE308	Electric Drives	3-0-0-3	2016

Prerequisite: EE202 & EE205

Course Objectives

- To provide fundamental knowledge in dynamics and control of Electric Drives.
- To justify the selection of Drives for various applications.
- To familiarize the various semiconductor controlled drives employing various motors.

Syllabus

Fundamentals of dynamics and control of electric drives– separately excited dc motor drives using controlled rectifiers — chopper controlled dc drives – ac voltage controllers – three phase induction motor speed control – VSI and CSI fed induction motor drives – synchronous motor drives

Expected outcome.

The students will be able to select a drive for a particular application. They will familiarize with the various control techniques employed for controlling drives with ac and dc motors.

Text books

1. Bimal K. Bose "Modern power electronics and AC drives" Pearson Education, Asia 2003
2. Dubey G. K. "Power semiconductor control drives" Prentice Hall, Englewood Cliffs, New Jersey, 1989

References:

1. Dewan S.B. , G. R. Slemon, A. Strauvhen, "Power semiconductor drives", John Wiley and sons
2. Dr. P. S. Bimbra "Power electronics", Khanna publishers
3. J. M. D. Murphy "Thyristor control of AC drives"
4. N. K. De, P. K. Sen "Electric drives" Prentice Hall of India 2002
5. Ned Mohan, Tore m Undeland, William P Robbins, "Power electronics converters applications and design", John Wiley and Sons.
6. Pillai S. K. "A first course on electric drives", Wieley Eastern Ltd, New Delhi
7. Vedam Subrahmanyam, "Electric Drives", MC Graw Hill Education, New Delhi
8. W. Shepherd, L. N. Hulley and D. T. Liang, "Power Electronocs and motor control", Second Edition, Cambridge University Press, 1995.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to electric drives – Block diagram – advantages of electric drives – Dynamics of motor load system, fundamental equations, and types of load – classification of load torque, four quadrant operation of drives. Steady state stability. Introduction to closed loop control of drives.	7	15%
II	DC motor drives- constant torque and constant power operation, separately excited dc motor drives using controlled rectifiers, single phase semi converter and single phase fully controlled converter drives. Three phase semi converter and fully controlled converter drives. Dual converters, applications of dual converter for speed control of DC motor. Closed loop control of separately excited dc motor drive. DC series motor drive for traction application.	7	15%
FIRST INTERNAL EXAMINATION			

III	Chopper controlled DC drives. Analysis of single quadrant chopper drives. Regenerative braking control. Two quadrant chopper drives. Four quadrant chopper drives. Cycloconverters for drive applications – different types – basic principle.	7	15%
IV	Three phase induction motor speed control. Using semiconductor devices. Stator voltage control – stator frequency control - Stator voltage and frequency control (v/f). Rotor chopper speed control - slip power recovery control schemes – sub synchronous and super synchronous speed variations.	7	15%
SECOND INTERNAL EXAMINATION			
V	Voltage source inverter fed induction motor drives, Current source inverter fed induction motor drives. Concept of space vector – Basic transformation in reference frame theory – field orientation principle.	7	20%
VI	Synchronous motor drives – introduction to v/f control. Permanent Magnet synchronous motor drives – different types – control requirements, converter circuits, modes of operation. Microcontroller based permanent magnet synchronous motor drives (schematic only).	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
EE 309	Microprocessor and Embedded Systems	3-0-0-3	2016

Course Objectives

To provide a strong foundation about the principles, programming and various applications of different microprocessors and microcontrollers

Syllabus:

Internal architecture, instruction set, assembly language programming, Sample Programs in assembly language of 8085 and8051 microcontroller-internal architecture,

Expected Outcome:

The students will be able to:

1. Apply the fundamentals of assembly level programming of 8085 microprocessor and8051 microcontroller
2. Work with standard microprocessor rreal time interfaces
3. Develop skill for writing C programs for8051 microcontroller
4. Design microprocessors/microcontrollers-based systems.

Text books:

1. Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill, Education, New
2. Mathur A., Introduction to Microprocessors, Tata McGraw Hill, New Delhi,1992.
3. Mohamed Ali Mazidi, Janice Gillispie Mazidi,"The8051 microcontroller and embedded systems using Assembly and C", second edition, Pearson
4. Rafiquzzaman, Microprocessor Theory and Application, PHI Learning, First Edition. 7.
5. Ramesh Gaonkar, Microprocessor, Architecture, Programming and Applications, Penram
6. Ray A joy and Burchandi, Advanced Microprocessor & Peripherals, Tata McGraw Hill, Education, New Delhi, Second Edition.
7. Scott MacKenzie, Raphael C W Phan,"The8051Microcontroller", Fourth Edition, Pearson education Delhi, Third Edition. /Prentice hall of India International Publishing; Sixth edition,2014.

CoursePlan

Module	Contents	Hours	End Sem. Exam Marks
I	Internal architecture of 8085 microprocessor–Instructionset-Addressing modes–Classification of instructions. Assembly language programming–standard programs in assembly language–code conversion, sorting–binary and BCD arithmetic.	7	15%
II	Stack and Subroutines–CALL and RETURN instructions–Delay subroutines. Timing and control–Machine cycles, instruction cycle and T states–fetch and execute cycles– Timing diagram for instructions.	7	15%
FIRSTINTERNALEXAMINATION			

III	IO and memory interfacing –Address decoding–interrupt Structure of 8085.I/O ports – Programmable peripheral interface PPI8255 -Modes of operation. Interfacing of LEDs, ADC and DAC with 8085	7	15%
IV	Introduction to Embedded Systems-Application domain of embedded systems, features and characteristics, System model, Microprocessor Vs Microcontroller, current trends and challenges, hard and soft real time systems, Embedded product development, Life Cycle Management (water fall model), Tool Chain System, Assemblers, Compilers, linkers, Loaders, Debuggers Profilers & Test Coverage Tools	7	15%
SECONDINTERNALEXAMINATION			
V	8051- Microcontrollers Hardware: Microcontroller Architecture: IO Port structure, Register organization, general purpose RAM, Bit Addressable RAM, Special Function Registers (SFRs). Instruction Set, addressing modes Instruction Types.	7	20%
VI	8051- assembly language programming, data types and directives, Time delay and I/O port programming, Embedded Programming in C, data type and time delay in C, I/O port programming, Timer / counter programming, serial port programming, Interfacing – LCD, ADC, Stepper motor, and DAC.	7	20%
ENDSEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.
One question from each module of Module I - IV; and two each from Module V & VI.
Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 questions:
(2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 questions:
(2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 questions:
(2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE331	Digital Circuits and Embedded Systems Lab	0-0-3-1	2016

Prerequisite: EE309 Microprocessor and embedded systems

Course Objectives

- To impart practical experience in the design and setup of digital circuits and embedded systems.

List of Exercises/Experiments : (Out of 18 experiments listed, 12 experiments are mandatory.**)**

DIGITAL CIRCUITS EXPERIMENTS : (at least 7 experiments are mandatory)

1. Realisation of SOP & POS functions after K map reduction
2. Half adder & Full adder realization using NAND gates
3. 4-bit adder/subtractor & BCD adder using IC 7483
4. BCD to decimal decoder and BCD to 7-segment decoder & display
5. Study of multiplexer IC and Realization of combinational circuits using multiplexers.
6. Study of counter ICs (7490, 7493)
7. Design of synchronous up, down & modulo N counters
8. Study of shift register IC 7495, ring counter and Johnsons counter
9. VHDL implementation of full adder, 4 bit magnitude comparator

EMBEDDED SYSTEM EXPERIMENTS: (**Out of first six, any two experiments using 8085 and any two using 8086. Out of the last 3 experiments, any two experiments using 8051 or any other open source hardware platforms like PIC, Arduino, MSP430, ARM etc)** (at least 5 experiments are mandatory)

1. Data transfer instructions using different addressing modes and block transfer.
2. Arithmetic operations in binary and BCD-addition, subtraction, multiplication and division
3. Logical instructions- sorting of arrays in ascending and descending order
4. Binary to BCD conversion and vice versa.
5. Interfacing D/A converter- generation of simple waveforms-triangular wave, ramp etc
6. Interfacing A/D converter
7. Square wave generation.
8. LED and LCD display interfacing
9. Motor control

Expected outcome.

The students will be able to

i. design, setup and analyse various digital circuits.
ii. design an embedded system for a particular application

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE332	Systems and Control laboratory	0-0-3-1	2016

Prerequisite: EE303 Linear control systems

Course Objectives

- To develop mathematical models for electrical systems, analyse the systems and implement compensators for systems based on system performance.

List of Experiments:

1. Predetermination and verification of frequency response characteristics of Lag and Lead networks.
2. Transfer Function of AC and DC servomotors
3. Step and frequency response of R-L-C circuit
4. Study of P, PI and PID controllers. Response analysis of a typical system with different controllers, using process control simulator.
5. Study of performance characteristics and response analysis of a typical temperature/ Flow/ Level control system.
6. MATLAB: Use of control system Tool box for the Time domain and frequency domain methods of system analysis and design
7. SIMULINK: Simulation and control of real time systems using SIMULINK
8. Compensator design using Bode plot with MATLAB control system Tool box
9. Simple experiments using Programmable Logic Controller- Realization of AND, OR logic, concept of latching, experiments with timers and counters- using ladder diagrams
10. Study of various types of synchros (TX, TR & TDX). Characteristics of transmitter, data transmission using TX-T R pair. Effect of TDX in data transmission.
11. Realization of Lag & lead compensator using active components

End examination shall be based on design of a controller for the given system

Course Outcome:

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

1. Develop mathematical models for servomotors and other electrical systems
2. Performance analysis of different process control systems
3. Performance analysis of different types of controllers
4. Use MATLAB and SIMULINK to design and analyze simple systems and compensators

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE333	Electrical Machines Lab II	0-0-3-1	2016

Prerequisite: EE202 Synchronous and induction machines

Course Objectives

- To give hands on experience in testing Alternators, Three phase and Single phase Induction Motors and induction generators

List of Exercises/Experiments:

1. Regulation of alternator by direct loading
   Objectives:
   a) Determine the regulation of three phase alternator
   b) Plot the regulation vs load curve
2. Regulation of three phase alternator by emf and mmf methods
   Objectives:
   Predetermine the regulation of alternator by emf and mmf method
3. Regulation of alternator by Potier and ASA methods
   Objectives:
   a) Synchronize the alternator by dark lamp method
   b) Plot ZPF characteristics and determine armature reactance mmf and potier reactance
   c) Predetermine the regulation by ZPF method
   d) Predetermine the regulation by ASA method
4. Regulation of alternator by Potier method using inductive load
   Objectives:
   a) Plot ZPF characteristics using a variable inductive load
   b) Predetrmine the regulation by ZPF method
5. Regulation of salient pole alternator using two reaction theory
   Objectives:
   a) Determine the direct and quadrature axis reactances.
   b) Predetermine the regulation of alternator
6. Active and reactive power control in grid connected alternators
   Objectives:
   a) Synchronize the alternator by bright lamp method
   b) Control the active and reactive power
   c) Plot the v-curve and inverted v curve for generator operation
7. Study of induction motor starters
   Objectives:
   a) Start an induction motor using star delta starter and determine the starting current
   b) Plot the dynamic characteristic during IM starting
8. Variation of starting torque with rotor resistance in slip-ring induction motors
   Objectives:
   a) Plot the variation of starting torque against rotor resistance in a three phase slip ring induction motor
   b) Find the external rotor resistance for which maximum starting torque is obtained.
9. Speed control of slip ring induction motor by varying rotor resistance
   Objectives:
   a) Run the slip ring induction motor with constant load torque
   b) Plot the variation of speed against change in rotor resistance
10. Load test on three phase squirrel cage induction motor
    Objectives:
    a) Start the motor using star delta starter
    b) Plot efficiency, line current and power factor against output power
11. Load test on three slip ring induction motor
    Objectives:
    a) Start the motor using auto transformer or rotor resistance starter

b) Plot efficiency, line current and power factor against output power

12. No load and block rotor test on three phase induction motor

Objectives:

a) Predetermination of performance characteristics from circle diagram

b) Determination of equivalent circuit

13. Performance characteristics of pole changing induction motor

Objectives:

a) Run the motor in two different pole combinations (example 4 pole and 8 pole)

b) Determine the performance in the two cases and compare

14. V curve of a synchronous motor

Objectives:

a) Run the motor in two different load conditions

b) Determine v-curve for each load condition

15. Performance characteristics of induction generator

Objective:

a) Run the induction generator with a dc motor prime mover.

c) Plot the performance characteristics of the generator

16. Equivalent circuit of single phase induction motor

Objectives:

a) Conduct no load and blocked tor test on the motor

c) Find the equivalent circuit

17. Electrical braking of slip ring induction motor

Objectives:

a) Dynamic braking

b) Plot the speed variations at different conditions

18. Separation of hysteresis loss in a three phase slip ring induction motor

Objective:

Determine the hysteresis loss in a slip ring induction motor

Out of the above experiments, minimum twelve experiments should be done.

Expected outcome:

- After the successful completion of the course, the students will be able to test and validate DC generators, DC motors and transformers

Text Book:

1. Bimbra P. S., *Electrical Machinery*, 7/e, Khanna Publishers, 2011.
2. Theraja B. L., *A Textbook of Electrical Technology*, S. Chand & Company, New Delhi, 2008.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE334	Power Electronics and Drives Lab	0-0-3-1	2016

Prerequisite: EE305 Power electronics

Course Objectives

- Impart practical knowledge for the design and setup of different power electronic converters and its application for motor control
- Simulate the various power electronics converters, AC drives and DC drives.

List of Exercises/Experiments: (12 experiments are mandatory**)**

HARDWARE EXPERIMENTS:

1. Static characteristics of SCR
   Aim: Determine latching current, holding current and static characteristics of SCR
2. R and RC firing circuits
   Aim: Design and set up R and RC firing circuits and observe waveforms across load resistance and SCR
3. UJT Trigger circuit with Single phase controlled Rectifier
   Aim: Design & Set up UJT Triggering Circuit and observe waveforms across load resistance, SCR, capacitance and pulse transformer output.
4. Line Synchronised Triggering Circuits
   Aim: Design and set-up line synchronized Ramp Trigger and Digital Trigger circuits and observe the waveforms
5. Static characteristics of MOSFET
   Aim: Plot the characteristics of a Power MOSFET
6. AC Voltage Controller using TRIAC
   Aim: Set a 1-phase AC voltage controller & observe waveforms across load resistance, TRIAC and capacitor for different firing angles
7. Single Phase fully Controlled SCR Bridge circuit
   Aim: Set up a 1-phase full converter with RL load & with and without freewheeling diode
8. Single-phase half bridge/full bridge inverter using power MOSFET/IGBT
   Aim: Design and set up a single phase half-bridge/full-bridge inverter and observe the waveforms across load and firing pulses.
9. Single-phase sine PWM inverter with LC filter
   Aim: Design and set up a single phase sine PWM inverter with LC filter using microcontroller
10. Chopper controlled DC motor
    Aim: Control the speed of a DC motor using a step-down chopper
11. Speed control of 3-phase induction motor
    Aim: Control the speed of 3-phase induction motor using V/f control
12. IGBT based three phase PWM Inverter
    Aim: Set up a 3-phase PWM Inverter with RL load and observe the waveforms
13. Closed Loop Control of Single Phase Fully Controlled Rectifier
    Aim: Design and set-up a closed loop control circuit for a 1ph Fully Controlled Rectifier such that it keeps the load voltage constant irrespective of the load variations (use R load)

SIMULATION EXPERIMENTS:

14. Simulation of 1-phase fully-controlled and half-controlled rectifier fed separately excited DC motor
    Aim: Simulate 1-phase fully-controlled and half-controlled rectifier fed SEDC motor and observe the speed, torque, armature current, armature voltage, source current waveforms and find the THD in source current and input power factor.

15. Simulation of closed loop speed control of DC motor with different control schemes (PID, hysteresis current control, Fuzzy, ANFIS etc)
16. Simulation of open loop or closed loop speed control of 3-phase induction motor using V/f control and using sine PWM
17. Design and simulation of buck, boost and buck-boost converters
18. Simulation of Dual Converter – 4 quadrant operation – separately excited DC motor
19. Simulation of Regenerative Braking – Bidirectional Power Transfer
20. Simulation of Switched Mode Rectifiers – keeping load voltage constant irrespective of line and load variations – closed loop circuit simulation

Minimum of EIGHT hardware experiments and FOUR simulation experiments from the above list are to be done

Expected outcome.

- Students will be able to design, setup and analyse various power electronic converters and apply these converters for the implementation of various motor control applications.

Text Book:

1) L. Umanand, *Power Electronics – Essentials & Applications*, Wiley-India

2) Mohan, Undeland, Robbins, *Power Electronics, Converters, Applications & Design*, Wiley-India

3) Muhammad H. Rashid, *Power Electronics Circuits, Devices and Applications*, Pearson Education

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE361	Object Oriented Programming	3-0-0-3	2016

Prerequisite: EE207 Computer programming

Course Objectives

- To familiarize the student with the Object Oriented Programming Concepts
- To give a fair idea about Programming in Java and its use as an Application development tool

Syllabus

Review of Object Oriented Concept, Components of Object oriented programming, File management concepts , Database programming, Application development concepts

Expected outcome.

- The students will be able to develop simple application programs using object oriented concepts and Java

Text Books:

1. Cay S. Horstmann and Gary Cornell, "Core Java: Volume I & II– Fundamentals", Pearson Education, 2008.
2. Herbert Schildt , The Complete Reference Java2, Eighth Edition, Tata McGraw Hill

References:

1. Doug Lea, Concurrent programming in Java Design Principles and Patterns, Pearson Education.
2. K. Arnold and J. Gosling, "The JAVA programming language", Pearson Education.
3. Timothy Budd, "Understanding Object-oriented programming with Java", Pearson Education. 3.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Review of Object Oriented Concepts - Objects and classes in Java – defining classes – methods – access specifiers	7	15%
II	– static methods– constructors, Arrays – Strings -Packages – JavaDoc comments,	7	15%
	FIRST INTERNAL EXAMINATION		
III	Inheritance – class hierarchy – polymorphism – dynamic binding – final keyword – abstract classes – the Object class – Reflection – interfaces – object cloning – inner classes	7	15%
IV	Streams and Files -Use of Streams, Object Streams, . Applet Basics-The Applet HTML Tags and Attributes, Multimedia, The Applet Context, JAR Files.	7	15%
	SECOND INTERNAL EXAMINATION		
V	File Management. Multithreaded programming– Thread properties – Creating a thread -Interrupting threads –Thread priority- thread synchronization – Synchronized method -Inter thread communication	7	20%
VI	Database Programming -The Design of JDBC, The Structured Query Language, JDBC Installation, Basic JDBC Programming Concepts, Query Execution	7	20%
	END SEMESTER EXAM		

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE362	Data Structures and Algorithms	3-0-0-3	2016

Prerequisite: EE207 Computer programming

Course Objectives

- To introduce the fundamental concept of data structures and to emphasize the importance of data structures in developing and implementing efficient algorithms
- To impart knowledge about algorithm specification

Syllabus

Linear Structures , Tree Structures , Applications of trees , Balanced Search Trees and Indexing , Graphs , Shortest-path algorithms , Applications of graphs , Algorithm Design , Algorithm Analysis , Dynamic programming

Expected outcome.

The students will be able to:

i. Describe how arrays, records, linked structures, stacks, queues, trees, and graphs are represented in memory and used by algorithms
ii. Describe common applications for arrays, records, linked structures, stacks, queues, trees, and graphs
iii. Write programs that use arrays, records, linked structures, stacks, queues, trees, and graphs
iv. Demonstrate different methods for traversing trees
v. Compare alternative implementations of data structures with respect to performance
vi. Compare and contrast the benefits of dynamic and static data structures implementations
vii. Describe the concept of recursion, give examples of its use, describe how it can be implemented using a stack

Text Book:

1. Robert Kruse, Data Structures and program design in C, Pearson Education Asia
2. Samanta,Classic Data Structures, PHI
3. Trembley & Sorenson, An introduction to Data Structures with applications:, McGraw Hill

References:

1. Donald E Knuth, The Art of Computer Programming, Vol.1: Fundamental Algorithms, Addison-Wesley, 1997.
2. Langsam, Augenstein & Tanenbaum, Data Structures using C & C++: Pearson, 1995
3. N.Wirth, Algorithms + Data Structures & Programs:, PHI
4. Sahni & Mehta, Fundamentals of Data Structures in C++: Horowitz, , Galgottia Pub.
5. Thomas Standish, Data structures in Java:, Pearson Education Asia

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Linear Structures : Abstract data types(ADT), List ADT, Array based implementation, Linked list implementation, Curser based linked lists, Doubly linked lists, Applications of lists, Stack ADT, Queue ADT, Circular queue implementation, Applications of stacks and queues	7	15%

II	Tree Structures : Need for nonlinear structures, Tree ADT, Tree traversals, Left child right sibling data structures for general trees, Binary tree ADT, Expression trees, Applications of trees, Binary search tree ADT	7	15%
FIRST INTERNAL EXAMINATION			
III	Balanced Search Trees and Indexing : AVL trees, Binary heaps, B-trees, Hashing, Separate chaining, Open addressing, Linear probing	7	15%
IV	Graphs : Definitions, Topological sort, Breadth-first traversal, Shortest-path algorithms, Minimum spanning tree, Prim's and Kruskal's algorithms, Depth-first traversal, Bio connectivity, Euler circuits, Applications of graphs	7	15%
SECOND INTERNAL EXAMINATION			
V	Algorithm Design: Greedy algorithm, Divide and conquer, Dynamic programming, Backtracking, Branch and bound, Randomized algorithms	7	20%
VI	Algorithm Analysis : Asymptotic notations, Recurrences, NP complete problems	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE363	Computer Organization and Architecture	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To lay the foundation for the study of hardware organization of digital computers.
- To impart the knowledge on interplay between various building blocks of computer

Syllabus

Basic operational concepts, CPU structure, Arithmetic, Memory hierarchy, Input Output interfacing, Performance analysis, Design

Expected outcome.

- The students will gain general idea about the functional aspects of each building blocks in computer design

Text Book:

W. Stallings, Computer Organization and Architecture: Designing for Performance, 8th Ed., Pearson Education India.

References:

1. D. A. Patterson and J. L. Hennessy, Computer Organization and Design, 4th Ed., Morgan Kaufmann, 2008.
2. Hamacher, Vranesic&Zaky, Computer Organization, McGraw Hill
3. Heuring V. P. & Jordan H. F., Computer System Design & Architecture, Addison Wesely

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Basic Structure of computers – functional units – Historical Perspective -Basic operational concepts – bus structures, Measuring performance: evaluating, comparing and summarizing performance	7	15%
II	Memory locations and addresses – memory operations – instructions and instruction sequencing ,Instruction sets- RISC and CISC paradigms, Addressing modes	7	15%
	FIRST INTERNAL EXAMINATION		
III	Computer arithmetic - Signed and unsigned numbers - Addition and subtraction - Logical operations - Constructing an ALU - Multiplication and division – faster versions of multiplication- floating point representation and arithmetic	7	15%
IV	The processor: Building a data path - Simple and multi-cycle implementations - Microprogramming – Exceptions	6	15%
	SECOND INTERNAL EXAMINATION		
V	Introduction to pipelining-pipeline Hazards, Memory hierarchy - Caches - Cache performance - Virtual memory - Common framework for memory hierarchies	7	20%
VI	Input/output - I/O performance measures – I/O techniques - interrupts, polling, DMA; Synchronous vs. Asynchronous I/O; Controllers. Types and characteristics of I/O devices - Buses - Interfaces in I/O devices - Design of an I/O system	8	20%
	END SEMESTER EXAM		

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE364	Switched Mode Power Converters	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To study and analyze various types of switched mode dc- dc converters, inverters and resonant converters and its switching techniques.

Syllabus

DC-DC convertors without isolation – switched mode power supply – DC-DC converters with isolation – switched mode DC-AC converter – sine PWM and space vector PWM - resonant converter

Expected outcome.

The students will have

i. ability to analyze and design switched mode power converters
ii. proper understanding about soft switching and its applications
iii. deep knowledge in pulse width modulated techniques

Text Book:

1. Mohan, Undeland, Robbins, *Power Electronics – Converters Application and Design*, Wiley-India
2. Muhammad H. Rashid, *Power Electronics – Circuits, Devices and Applications*, Pearson Education

References:

1. Abraham Pressman, *Switching Power supply Design*, McGraw Hill

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Switched Mode DC-to-DC Converter - buck converters – boost Converter – buck-boost converter - Continuous Conduction mode – design of filter inductance & capacitance - boundary between continuous and discontinuous conduction – critical values of inductance/load resistance - discontinuous conduction mode with constant output voltage - Output voltage ripple	7	15%
II	Cuk converter – Full-ridge dc-dc Converter – PWM with bipolar voltage and unipolar voltage switching –comparison of dc-dc converters - Linear Power Supply – disadvantages of linear power supply – switched mode power supply – dc-dc converters with electrical isolation –unidirectional core excitation & bidirectional core excitation	7	15%
FIRST INTERNAL EXAMINATION			
III	Fly back converter – continuous & discontinuous conduction mode - double ended fly back converter – forward converters – basic forward converter – practical forward converter – continuous conduction mode only - double ended forward converter – push pull converter – half bridge converter – full bridge converter – continuous conduction mode – current source dc-dc converter	7	15%
IV	Switched Mode DC to AC converter – 1-phase square wave full-bridge inverter – square wave switching scheme - sine PWM switching scheme – PWM with bipolar & unipolar voltage switching - harmonic analysis of output voltage – output control by voltage cancellation - 3-phase voltage source inverter – 3-phase sine PWM inverter – RMS line to line voltage & RMS fundamental line-to-line voltage – square wave operation -	8	15%

	Switching utilisation ratio of 1-phase & 3-phase full-bridge inverters		
SECOND INTERNAL EXAMINATION			
V	Concept of space vector – space vector modulation – reference vector & switching times – space vector sequence – comparison of sine PWM & space vector PWM - programmed (selective) harmonic elimination switching – current controlled voltage source inverter - hysteresis current control	6	20%
VI	Resonant Converters - Basic resonant circuit concepts – series resonant circuit – parallel resonant circuit – load resonant converter - ZCS resonant converter - L type & M type - ZVS resonant converter – comparison of ZCS & ZVS Resonant Converters	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE365	Digital System Design	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To enable designing and building of real digital circuits
- To implement VHDL programming in digital system design

Syllabus

Combinational logic using VHDL gate models, Combinational building blocks, Synchronous Sequential Design, VHDL Models of Sequential Logic Blocks, Complex Sequential Systems, VHDL Simulation, VHDL Synthesis, Testing Digital Systems, Design for Testability.

Expected outcome.

After completing the course, the students will be able to

i. Design any Digital Circuit for practical application
ii. Implement any digital system using VHDL
iii. Program any VHDL code for practical implementation
iv. Hardware realization of any complex VHDL system.

Text Book:

Mark Zwolinski, Digital System Design with VHDL, Second Edition, Pearson Education.2007

References:

1. A Anandakumar, Digital Electronics,Prentice Hall India Feb 2009.
2. John F Wakerly, Digital Design, Pearson Education, Delhi, 2002
3. Morris Mano,Digital Design, Pearson Education, Delhi, 2002

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction : Modern Digital Design, CMOS Technology, Programmable Logic ,Electrical Properties Combinational Logic Design : Boolean Algebra , Logic Gates, Combinational Logic Design, Timing, Number codes	4	15%
II	Combinational Logic using VHDL Gate Models : Entities and Architectures ,Identifiers , Spaces and Comments ,Net lists , Signal Assignments ,Generics ,Constant and Open Ports ,Test benches, Configurations Combinational Building Blocks : Three-Stat Buffers , Decoders ,Multiplexers, Priority Encoders , Adders, Parity Checkers , Test benches for Combinational blocks	8	15%
FIRST INTERNAL EXAMINATION			
III	Synchronous Sequential Design : Synchronous Sequential Systems , Models of Synchronous Sequential Systems, Algorithmic State Machines ,Synthesis from ASM chart , State Machines in VHDL , VHDL Test benches for State Machines	7	15%

IV	VHDL Models of Sequential Logic Blocks : Latches , Flip-Flops , J K and T Flip Flop , Registers and Shift Registers ,Counters , Memory, Sequential Multiplier, Test benches for Sequential Building Blocks Complex Sequential Systems : Data path / Control Partitioning ,Instructions, A Simple Microprocessor, VHDL model of a Simple Microprocessor	8	15%
SECOND INTERNAL EXAMINATION			
V	VHDL Simulation: Event Driven Simulation, Simulation of VHDL models , Simulation modelling issues , Fire Operations . VHDL Synthesis : RTL Synthesis , Constraints ,Synthesis for FPGAs ,Behavioural Synthesis , Verifying Synthesis Results	8	20%
VI	Testing Digital Systems : Need for Testing , Fault Models , Fault oriented Test Pattern Generation , Fault Simulation, Fault Simulation in VHDL Design for Testability : Ad Hoc Testability improvements , Structured Design for Test , Built-in-Self-Test , Boundary scan (IEEE 1149 .1)	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE366	Illumination Technology	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- Toprovide an introduction to the fundamentals of illumination engineering and architectural lighting design.
- To impart lighting fundamentals, measurement, and technology and their application in the analysis and design of architectural lighting systems

Syllabus

Introduction of Light , Types of illumination , Lighting systems , Lighting Scheme , Measurement of Light , Laws of illumination , Design of Interior Lighting, Determination of Lamp Lumen output taking into account voltage and temperature variations , Indian standard recommendation and standard practices for illumination levels in various areas, Special feature for entrance, staircase, Corridor lighting and industrial building , Design of Outdoor Lighting , Special Features of Aesthetic Lighting

Expected outcome.

The students will be able to:

i. Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space
ii. Perform calculations on photometric performance of light sources and luminaires for lighting design
iii. Evaluate different types of lighting designs and applications

Text Books

1. D.C. Pritchard Lighting, Routledge, 2016
2. Jack L. Lindsey, Applied Illumination Engineering , PHI, 1991
3. John MatthewsIntroduction to the Design and Analysis of Building Electrical Systems, Springer, 1993
4. M.A. Cayless, Lamps and Lighting , Routledge, 1996

References:

1. IS CODE 3646
2. IS CODE 6665

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction of Light : Types of illumination, Day lighting, Supplementary artificial lighting and total lighting, Quality of good lighting, Factors affecting the lighting-shadow,glare,reflection, Colour rendering and stroboscopic effect, Methods of artificial lighting, Lighting systems-direct, indirect, semi direct, semi indirect, Lighting scheme, General and localised	6	15%
II	Measurement of Light : Definition of luminous flux, Luminous intensity, Lumen, Candle power, Illumination, M.H.C.P, M.S.C.P, M.H.S.C.P, Lamp efficiency, Brightness or luminance, Laws of illumination, Inverse square law and Lambert's Cosine law, Illumination at horizontal and vertical plane from point source, Concept of polar curve, Calculation of luminance and illumination in case of linear source, round source and flat source	7	15%
FIRST INTERNAL EXAMINATION			

III	Design of Interior Lighting : Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it, Illumination required for various work planes, Space to mounting height ratio, Types of fixtures and relative terms used for interior illumination such as DLOR and ULOR, Selection of lamp and luminance, Selection of utilisation factor, reflection factor and maintenance factor Determination of Lamp Lumen output taking into account voltage and temperature variations, Calculation of wattage of each lamp and no of lamps needed, Layout of lamp luminaire, Calculation of space to mounting height ratio, Indian standard recommendation and standard practices for illumination levels in various areas, Special feature for entrance, staircase, Corridor lighting and industrial building	8	15%
IV	Design of Outdoor Lighting : Street Lighting : Types of street and their level of illumination required, Terms related to street and street lighting, Types of fixtures used and their suitable application, Various arrangements in street lighting, Requirements of good street lighting, Selection of lamp and luminaire, Calculation of their wattage, Number and arrangement, Calculation of space to mounting height ratio, Calculation of illumination level available on road	7	15%
SECOND INTERNAL EXAMINATION			
V	Design of Outdoor Lighting : Flood Lighting : Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp and projector, Calculation of their wattage and number and their arrangement, Calculation of space to mounting height ratio, Recommended method for aiming of lamp	7	20%
VI	Special Features of Aesthetic Lighting : Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE367	New and Renewable Energy Systems	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To give sufficient knowledge about the promising new and renewable sources of energy
- To equip students in working with projects and to take up research work in connected areas.

Syllabus:

Solar energy - Solar radiation measurements - Applications of solar energy - Energy from oceans- Tidal energy - Wind energy -Small Hydro Power (SHP) Stations- Biomass and bio-fuels - geothermal energy -Power from satellite stations - Hydrogen energy.

Expected Outcome:

- The students will be able to design and analyse the performance of small isolated renewable energy sources.

References:

1. A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
2. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001..
3. Boyle G. (ed.), Renewable Energy - Power for Sustainable Future, Oxford University Press, 1996
4. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
5. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
6. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
7. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994
8. Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, Renewable Energy – Sources for Fuel and Electricity, Earth scan Publications, London, 1993.
9. Khan B. H., Non-Conventional Energy Resources, Tata McGraw Hill, 2009.
10. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 1999.
11. Sab S. L., Renewable and Novel Energy Sources, MI. Publications, 1995.
12. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
13. Tiwari G. N., Solar Energy- Fundamentals, Design, Modelling and Applications, CRC Press, 2002.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction, Classification of Energy Resources; Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario. ENERGY STORAGE: Sizing and Necessity of Energy Storage.	5	15%
II	SOLAR THERMAL SYSTEMS: Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data – Pyranometer and Pyrheliometer .Principle of Conversion of Solar Radiation into Heat, – Solar thermal collectors – General description	11	15%

	and characteristics – Flat plate collectors – Heat transfer processes – Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) –performance evaluation..		
FIRST INTERNAL EXAMINATION			
III	SOLAR ELECTRIC SYSTEMS: Solar Thermal Electric Power Generation –; Solar Photovoltaic – Solar Cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems – stand-alone and grid connected; Applications – Street lighting, Domestic lighting and Solar Water pumping systems..	5	15%
IV	ENERGY FROM OCEAN: Tidal Energy – Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Advantages and Limitations of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.	7	15%
SECOND INTERNAL EXAMINATION			
V	WIND ENERGY: Introduction, Wind and its Properties, History of Wind Energy, Wind Energy Scenario – World and India. Basic principles of Wind Energy Conversion Systems (WECS), Classification of WECS, Parts of WECS, Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS, Advantages and Disadvantages of WECS	7	20%
VI	BIOMASS ENERGY: Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, factors affecting biogas generation, types of biogas plants – KVIC and Janata model; Biomass program in India. Small hydro power: Classification as micro, mini and small hydro projects - Basic concepts and types of turbines - Design and selection considerations. EMERGING TECHNOLOGIES: Fuel Cell, Small Hydro Resources, Hydrogen Energy, alcohol energy, nuclear fusion and power from satellite stations.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions. One question from each module of Module I - IV; and two each from Module V & VI. Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE368	SOFT COMPUTING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To provide the students with the concepts of soft computing techniques such as neural networks, fuzzy systems, genetic algorithms

Syllabus

Introduction to Soft Computing and Neural Networks , Fuzzy Sets and Fuzzy Logic: Fuzzy Sets, Neuro-Fuzzy Modelling , Machine Learning , Machine Learning Approach to Knowledge Acquisition

Expected outcome.

The students will be able to get an idea on :

i. Artificial Intelligence, Various types of production systems, characteristics of production systems.
ii. Neural Networks, architecture, functions and various algorithms involved.
iii. Fuzzy Logic, Various fuzzy systems and their functions.
iv. Genetic algorithms, its applications and advances
v. The unified and exact mathematical basis as well as the general principles of various soft computing techniques.

Text Book:

1. Digital Neural Network -S.Y Kung , Prentice-Hall of India
2. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Pearson Edn.,
3. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India,

References:

1. Amit Konar, "Artificial Intelligence and Soft Computing", First Edition,CRC Press, 2000.
2. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley
3. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall
4. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998.
5. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Prentice Hall,

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction To Soft Computing And Neural Networks : Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence - Adaptive Networks – Feed forward Networks – Supervised Learning	7	15%
II	Neural Networks – Radia Basis Function Networks - Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures. Fuzzy Sets And Fuzzy Logic: Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations - Fuzzy Rules and Fuzzy Reasoning	7	15%
FIRST INTERNAL EXAMINATION			
III	Fuzzy Inference Systems – Fuzzy Logic – Fuzzy Expert Systems – Fuzzy Decision Making Neuro-Fuzzy Modeling : Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees	7	15%

IV	Data Clustering Algorithms – Rulebase Structure Identification Neuro-Fuzzy Control.	7	15%
SECOND INTERNAL EXAMINATION			
V	Machine Learning : Machine Learning Techniques – Machine Learning Using Neural Nets – Genetic Algorithms (GA)	7	20%
VI	Applications of GA in Machine Learning - Machine Learning Approach to Knowledge Acquisition. Support Vector Machines for Learning – Linear Learning Machines – Support Vector Classification – Support Vector Regression - Applications.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE369	High Voltage Engineering	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To understand generation and measurement techniques of high voltage DC, AC and impulse voltages
- To understand various types of testing techniques used in power equipments and design of high voltage lab and the grounding of impulse testing laboratories.

Syllabus :

Generation of HVDC, HVAC and impulse wave forms,-measurement techniques-non destructive testing techniques- testing of power equipments, design of testing lab and grounding of laboratories

Expected outcome.

- The students will know several of methods of generating different test voltages, testing methods used in power equipments and design of high voltage laboratories.

Text Book:

- C.L Wadhwa *High voltage Engineering*, New age international (P) ltd, 2007

References:

1. Dieter Kind, Kurt Feser, "High voltage test techniques", SBA Electrical Engineering Series, New Delhi, 1999.
2. Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India P Ltd, 2005
3. Naidu M.S. and Kamaraju V., "High voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Generation and transmission of electric energy – voltage stress – testing voltages-AC to DC conversion – rectifier circuits – cascaded circuits – voltage multiplier circuits – Cockroft-Walton circuits – voltage regulation – ripple factor – Van de-Graaff generator.	7	20%
II	Generation of high AC voltages-Testing transformer – single unit testing transformer, cascaded transformer – equivalent circuit of cascaded transformer – generation of high frequency AC voltages-series resonance circuit – resonant transformer – voltage regulation.	7	20%
	FIRST INTERNAL EXAMINATION		
III	Generation of impulse voltages-Marx generator – Impulse voltage generator circuit –analysis of various impulse voltage generator circuits - multistage impulse generator circuits – Switching impulse generator circuits – impulse current generator circuits	7	15%
IV	Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method	7	15%

	– voltage dividers and impulse voltage measurements- measurement of impulse currents		
SECOND INTERNAL EXAMINATION			
V	Objectives of high voltage testing, Classification of testing methods-self restoration and non-self restoration systems-standards and specifications, Measurement of dielectric constant and loss factor, Partial discharge measurements-Basic partial discharge(PD) circuit – PD currents- PD quantities - Corona and RIV measurements	7	15%
VI	Testing of insulators, bushings, air break switches, isolators, circuit breakers, power transformers, surge diverters, cables -testing methodology. Classification of high voltage laboratories, Voltage and power rating of test equipment, Layout of high voltage laboratories, Grounding of impulse testing laboratories.	10	15%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.
One question from each module of Module I - IV; and two each from Module V & VI.
Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE372	Biomedical Instrumentation	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To give a brief introduction to human physiology and various instrumentations system for measurement and analysis of physiological parameters.

Syllabus:

Development of biomedical instrumentation, Sources of bioelectric potentials, Bio potential electrodes, Electro-conduction system of the heart, Measurement of blood pressure, Measurement of heart sounds, Cardiac pacemakers, defibrillators, Electro encephalogram, Muscle response, Respiratory parameters, Therapeutic Equipments, Imaging Techniques, Instruments for clinical laboratory, Electrical safety, tele- medicine

Expected outcome.

Text Book:

1. J. G. Webster, Medical Instrumentation, Application and Design, John Wiley and Sons
2. L. Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson education, Delhi, 1990.

References:

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
2. J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Development of biomedical instrumentation, biometrics, man instrument system components block diagram, physiological systems of the body (brief discussion on Heart and cardio vascular system, Anatomy of nervous system, Physiology of respiratory systems) problems encountered in biomedical measurements. Sources of bioelectric potentials – resting and action potentials - propagation of action potentials – bio electric potentials example (ECG, EEG, EMG, ERG, EOG,EGG etc.)	7	15%
II	Bio potential electrodes – theory – microelectrodes – skin surface electrodes – needle electrodes – biochemical transducers – transducers for biomedical applications. Electro-conduction system of the heart. Electro cardiography – electrodes and leads – Einthoven triangle, ECG read out devices, ECG machine – block diagram.	7	15%
FIRST INTERNAL EXAMINATION			
III	Measurement of blood pressure – direct and indirect measurement – oscillometric measurement –ultrasonic method, measurement of blood flow and cardiac output, plethysmography –photo electric and impedance plethysmographs Measurement of heart sounds –phonocardiography.	7	15%

IV	Cardiac pacemakers – internal and external pacemakers, defibrillators. Electro encephalogram –neuronal communication – EEG measurement. Muscle response– Electromyogram (EMG) – Nerve Conduction velocity measurements- Electromyogram Measurements. Respiratory parameters – Spiro meter, pneumograph	7	15%
SECOND INTERNAL EXAMINATION			
V	Ventilators, heart lung machine, hemodialysis, lithotripsy, infant incubators X-rays- principles of generation, uses of X-rays- diagnostic still picture, fluoroscopy, angiography, endoscopy, diathermy. Basic principle of computed tomography, magnetic resonance imaging system and nuclear medicine system – radiation therapy. Ultrasonic imaging system - introduction and basic principle.	8	20%
VI	Instruments for clinical laboratory – test on blood cells – chemical tests - Electrical safety– physiological effects of electric current – shock hazards from electrical equipment – method of accident prevention, introduction to tele- medicine.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hourrs.

Part A: 8 compulsory questions.

One question from each module of Modules I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.