APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Curriculum

for

B.Tech Degree

Semesters III to VIII

2016

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

CET CAMPUS, THIRUVANANTHAPURAM – 695016

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BRANCH: *Electrical & Electronics Engineering*

SEMESTER - 3

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA201	Linear Algebra & Complex Analysis	3-1-0	4	A
EE201	Circuits and, Networks	3-1-0	4	B
EE203	Analogue Electronic Circuits	3-1-0	4	C
EE205	DC Machines and Transformers	3-1-0	4	D
EE207	Computer Programming	2-1-0	3	E
HS200/ HS210	Business Economics/Life Skills	3-0-0/ 2-0-2	3	F
EE231	Electronic Circuits Lab	0-0-3	1	S
EE233	Programming Lab	0-0-3	1	T

Total Credits = 24 Hours: 28/29

Cumulative Credits= 71

SEMESTER - 4

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA202	Probability Distributions, Transforms and Numerical Methods	3-1-0	4	A
EE202	Synchronous and Induction Machines	3-1-0	4	B
EE204	Digital Electronics and Logic Design	2-1-0	3	C
EE206	Material Science	3-0-0	3	D
EE208	Measurements and Instrumentation	3-1-0	4	E
HS210/ HS200	Life Skills/Business Economics	2-0-2/ 3-0-0	3	F
EE232	Electrical Machines Lab I	0-0-3	1	S
EE234	Circuits and Measurements Lab	0-0-3	1	T

Total Credits = 23 Hours 28/27 Cumulative Credits= 94

BRANCH: *Electrical & Electronics Engineering*

SEMESTER - 5

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
EE301	Power Generation, Transmission and Protection	3-1-0	4	A
EE303	Linear Control Systems	2-1-0	3	B
EE305	Power Electronics	3-0-0	3	C
EE307	Signals and Systems	3-0-0	3	D
EE309	Microprocessor and Embedded Systems	2-1-0	3	E
	Elective 1	3-0-0	3	F
EE341	Design Project	0-1-2	2	S
EE331	Digital Circuits and Embedded Systems Lab	0-0-3	1	T
EE333	Electrical Machines Lab II	0-0-3	1	U

Total Credits = 23 **Hours: 28** **Cumulative Credits= 117**

Elective 1:-
1. EE361 Object Oriented Programming
2. EE363 Computer Organization and Architecture
3. EE365 Digital System Design
4. EE367 New and Renewable Energy Systems
5. EE369 High Voltage Engineering

BRANCH: *Electrical & Electronics Engineering*

SEMESTER - 6

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
EE302	Electromagnetics	2-1-0	3	A
EE304	Advanced Control Theory	3-1-0	4	B
EE306	Power System Analysis	3-0-0	3	C
EE308	Electric Drives	3-0-0	3	D
HS300	Principles of Management	3-0-0	3	E
	Elective 2	3-0-0	3	F
EE332	Systems and Control Lab	0-0-3	1	S
EE334	Power Electronics and Drives Lab	0-0-3	1	T
EE352	Comprehensive Exam	0-1-1	2	U

Total Credits = 23 **Hours: 27** **Cumulative Credits= 140**

Elective 2:-

1. EE362 Data Structures and Algorithms
2. EE364 Switched Mode Power Converters
3. EE366 Illumination Technology
4. EE368 Soft Computing
5. EE372 Biomedical Instrumentation

BRANCH: *Electrical & Electronics Engineering*

SEMESTER - 7

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
EE401	Electronic communication	2-1-0	3	A
EE403	Distributed generation and smart grids	3-0-0	3	B
EE405	Electrical system design	3-1-0	4	C
EE407	Digital Signal Processing	3-0-0	3	D
EE409	Electrical Machine Design	3-0-0	3	E
	Elective 3	3-0-0	3	F
EE451	Seminar & Project Preliminary	0-1-4	2	S
EE431	Power system Lab	0-0-3	1	T

Total Credits = 22 **Hours: 27** **Cumulative Credits= 162**

Elective 3:-

1. EE461 Modern Operating Systems
2. EE463 Computer Aided Power Systems Analysis
3. EE465 Power Quality
4. EE467 Nonlinear Control Systems
5. EE469 Electric and Hybrid Vehicles

BRANCH: *Electrical & Electronics Engineering*

SEMESTER - 8

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
EE402	Special Electric Machines	3-0-0	3	A
EE404	Industrial Instrumentation & Automation	3-0-0	3	B
	Elective 4	3-0-0	3	C
	Elective 5 (Non Departmental)	3-0-0	3	D
EE492	Project		6	

Total Credits = 18 **Hours: 29** **Cumulative Credits= 180**

Elective 4:-

1. EE462 Design of Digital Control Systems
2. EE464 FACTS
3. EE466 Digital Image Processing
4. EE468 Computer Networks
5. EE472 Internet of Things
6. EE474 Energy Management and Auditing

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE201	CIRCUITS AND NETWORKS	3-1-0-4	2016

Prerequisite: Nil

Course Objectives:

To learn about various techniques available to solve various types of circuits and networks

To gain the capability to synthesize a circuit for a particular purpose.

Syllabus AC Circuit Analysis(Steady State AC Analysis), Network topology, Transient analysis,

Laplace transform– properties , Transformed circuits, Two port networks, Symmetrical two port reactive networks as filters, Network functions, Network Synthesis

Expected outcome.

Ability to solve any DC and AC circuits

Ability to apply graph theory in solving networks

Ability to apply Laplace Transform to find transient response

Ability to synthesize networks

Text Book:

1. Hayt and Kemmerly :Engineering Circuit Analysis, 8e, Mc Graw Hill Education , New Delhi, 2013.
2. Sudhakar and Shyam Mohan- Circuits and Networks: Analysis and Synthesis, 5e, Mc Graw Hill Education,

Data Book (Approved for use in the examination): Nil

References:

1. Siskand C.S : Electrical Circuits ,McGraw Hill
2. Joseph. A. Edminister: Theory and problems of Electric circuits, TMH
3. D Roy Chaudhuri: Networks and Systems, New Age Publishers
4. A . Chakrabarti : Circuit Theory (Analysis and Synthesis),Dhanpat Rai &Co
5. Valkenberg : Network Analysis ,Prentice Hall of India
6. B.R. Gupta: Network Systems and Analysis, S.Chand & Company ltd

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Network theorems – Superposition theorem – Thevenin's theorem – Norton's theorem – Reciprocity Theorem – Maximum power transfer theorem – dc and ac steady state analysis – dependent and independent sources	9 hours	15%
II	Network topology – graph, tree, incidence matrix – properties of incidence matrix – fundamental cut sets – cut set matrix – tie sets – fundamental tie sets – tie set matrix – relationships among incidence matrix, cut set matrix & tie set matrix – Kirchoff's laws in terms of network topological matrices – formulation and solution of network equations using topological methods	9 hours	15%

FIRST INTERNAL EXAMINATION			
III	Steady state and transient response – DC response & sinusoidal response of RL, RC and RLC series circuits	**9 hours**	15%
IV	Application of Laplace transform in transient analysis – RL, RC and RLC circuits (Series and Parallel circuits) – step and sinusoidal response Transformed circuits – coupled circuits - dot convention - transform impedance/admittance of RLC circuits with mutual coupling – mesh analysis and node analysis of transformed circuits – solution of transformed circuits including mutually coupled circuits in s-domain	**10 hours**	15%
SECOND INTERNAL EXAMINATION			
V	Two port networks – Z, Y , h, T parameters – relationship between parameter sets – condition for symmetry & reciprocity – interconnections of two port networks – driving point and transfer immittance – T-π transformation.	**9 hours**	20%
VI	Network functions–Network synthesis-positive real functions and Hurwitz polynomial-synthesis of one port network with two kinds of elements-Foster form I&II-Cauer form I&II.	**8 hours**	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV

Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI

Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No	Course Name	L-T-P-Credits	Year of Introduction
EE202	**Synchronous and Induction Machines**	3-1-0-4	2016

Prerequisite : NIL

Course Objectives

To give exposure to the students about the concepts of alternating current machines including the Constructional details, principle of operation and performance analysis.

To learn the characteristics of induction machines and to learn how it can be employed for various applications.

Syllabus

Alternators – basic principle, constructional details, armature windings, armature reaction, voltage regulation and determination of regulation by different methods; parallel operation of alternators and synchronization; Synchronous motors – principle, performance and power relations; synchronous induction motors.

Induction motors – basic principle, rotating magnetic field, constructional details, mechanical power and torque, performance analysis, starting methods, braking, testing, equivalent circuit and circle diagrams; single phase induction motors.

Induction generator – principle of operation.

Expected Outcome

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

1. identify alternator types, and appreciate their performance
2. determine the voltage regulation and analyse the performance of alternators
3. describe the principle of operation of synchronous motor and different applications.
4. describe the principle of operation of 3-phase induction motors and select appropriate motor types for different applications.
5. analyse the performance of 3-phase induction motors
6. familiarize with principle of operation and application of 1 -phase induction motors.

Text Book

1. Bimbra P. S., *Electrical Machinery*, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D. P. Kothari, *Theory of AC Machines*, Tata McGraw Hill, 2006.

Reference Books

1. Say M. G., *The Performance and Design of A. C. Machines*, C B S Publishers, New Delhi, 2002.
2. Fitzgerald A. E., C. Kingsley and S. Umans, *Electric Machinery*, 6/e, McGraw Hill, 2003.
3. Langsdorf M. N., *Theory of Alternating Current Machinery*, Tata McGraw Hill, 2001.
4. Deshpande M. V., *Electrical Machines*, Prentice Hall India, New Delhi, 2011.
5. Charles I. Hubert, Electric Machines, Pearson, New Delhi 2007
6. Theodore Wilde, *Electrical Machines, Drives and Power System*, Pearson Ed. Asia 2001.

Course Plan

Module	Contents	Hours	Semester Exam Marks
I	Alternators - basic principle, constructional features of salient pole type and cylindrical type alternators, advantages of stationary armature, turbo-alternator. Armature winding – types of armature winding- single layer, double layer, full pitched and short pitched winding,	8 hours	15%

	slot angle, pitch factor and distribution factor – numerical problems. Effect of pitch factor on harmonics – advantages of short chorded winding, EMF Equation – numerical problems. Harmonics in generated EMF – suppression of harmonics.		
II	Performance of an alternator – Causes for voltage drop in alternators – armature resistance, armature leakage reactance – armature reaction, synchronous reactance, synchronous impedance, experimental determination – phasor diagram of a loaded alternator. Voltage regulation – EMF, MMF, ZPF and ASA methods – numerical problems.	9 hours	15%
FIRST INTERNAL EXAMINATION			
III	Theory of salient pole machine – Blondel's two reaction theory – direct axis and quadrature axis synchronous reactances – phasor diagram and determination of X_d and X_q by slip test. Parallel operation of alternators – necessity of parallel operation of alternators, methods of synchronisation– dark lamp method and bright lamp method, synchroscope, Synchronising current, synchronising power, synchronising torque. Effects of changing excitation of alternators, load sharing of two alternators in parallel operation.	9 hours	15%
IV	Synchronous motor – construction and principle of synchronous motor, methods of starting. Effects of excitation on armature current and power factor, v-curve and inverter v-curve, load angle, torque and power relationship, phasor diagram, losses and efficiency calculations. Three phase induction motor – constructional features, slip ring and cage types. Theory of induction motor with constant mutual flux, slip, phasor diagram, expression for mechanical power and torque, torque-slip characteristics, starting torque, full load and pull out torque, equivalent circuit.	9 hours	15%
SECOND INTERNAL EXAMINATION			
V	Circle diagrams – tests on induction motors for determination of equivalent circuit and circle diagram.	10 hours	20%

	Cogging, crawling and noise production in cage motors – remedial measures. Double cage induction motor – principle, torque-slip curves. Starting of induction motors – types of starters – DOL starter, autotransformer starter, star-delta starter, rotor resistance starter – starting torque and starting current-numerical problems. Braking of induction motors – plugging, dynamic braking and regenerative braking (no numerical problems). Speed control – stator voltage control, V/f control, rotor resistance control.		
VI	Induction generator – principle of operation, grid connected and self excited operation, comparison of induction generator with synchronous generators. Synchronous induction motor – principle of operation. Single-phase induction motor – double field revolving theory, equivalent circuit, torque slip curve. Types of single phase induction motor – split phase, capacitor start, capacitor start and run types. Principle of shaded pole motor – applications.	10 hours	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV

Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI

Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE203	ANALOG ELECTRONICS CIRCUITS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To impart an in depth knowledge in electronic semiconductor devices & circuits giving importance to the various aspects of design & analysis.
- To provide knowledge about different types amplifier & oscillator circuits and their design.
- To provide a thorough understanding of the operational amplifier circuits and their functions.

Prerequisites: Nil

Syllabus Diode clipping and clamping circuits and Zener voltage regulators, BJT biasing, AC Equivalent Circuit of BJT and CE amplifier analysis, Biasing of JFET and MOSFET, Frequency response of BJT and FET amplifiers, Power amplifiers using BJT, Feedback amplifiers &Oscillator Circuits

Operational Amplifier basics and OP-AMP Circuits, Wave form generation using Op-Amp, Multivibrators using Timer IC 555.

Expected outcome: Upon successful completion of the course the students will be able to

1. Design biasing scheme for transistor circuits
2. Model BJT and FET amplifier circuits
3. Choose a power amplifier with appropriate specifications for electronic circuit applications
4. Design & analyse oscillator circuits using BJT
5. Choose Operational amplifier(OPAMP) for specific applications including waveform generation.
6. Design & implement analog circuits using OPAMPs

Text Book:

1. Malvino A. and D. J. Bates, Electronic Principles 7/e, Tata McGraw Hill, 2010.
2. Boylestad R. L. and L. Nashelsky, Electronic Devices and Circuit Theory, 10/e, Pearson Education India, 2009.
3. Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.

Data Book (Approved for use in the examination): Nil

References:

1. Floyd T. L., Fundamentals of Analog Circuits,, Pearson Education, 2012.
2. Robert T. Paynter and John Clemons, Paynter's Introductory electronic devices & circuits, Prentice Hall Career & Technology, New Jersey.
3. Bell D. A., Electronic Devices and Circuits, Prentice Hall of India, 2007.
4. Millman J. and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw-Hill, 2010.
5. Streetman B. G. and S. Banerjee, Solid State Electronic Devices, Pearson Education Asia, 2006.
6. Gayakward R. A., Op-Amps and Linear Integrated Circuits, PHI Learning Pvt. Ltd., 2012.

Course Plan			
Module	**Contents**	**Hours**	**Sem.ExamMarks**
I	**Diode Circuits**: Diode clipping circuits - Single level and two level clippers - Clamping circuits – Design of Zener Voltage Regulators. **Bipolar Junction Transistors** : Review of BJT characteristics- Operating point of a BJT – Factors affecting stability of Q point and DC Biasing – Biasing circuits: fixed bias, collector to base bias, voltage division bias and self bias. (Derivation of stability factors for Voltage Divider Biasing only) –Bias compensation using diode and thermistor. Low frequency equivalent circuit of BJT. Common Emitter amplifier - AC Equivalent Circuit – Role of coupling and emitter bypass capacitors – h parameter model of BJT -Amplifier gains and impedances calculations using h equivalent circuit.	9 hours	15%
II	**Field Effect Transistors** : Review of JFET and MOSFET construction, working and characteristics- Biasing a JFET and MOSFET using voltage divider bias–- CS and CD amplifiers – small signal models-FET as switch and voltage controlled resistance. **Frequency response of Amplifiers** : Miller's Theorem-BJT Internal Capacitances at high frequency operations-High frequency analysis of CE Amplifier using hybrid Pi Model -Low Frequency Response of Common Emitter amplifier -– CE High frequency response-Gain bandwidth product- ––Low and High Frequency response of FET amplifiers	9 hours	15%
FIRST INTERNAL EXAMINATION			
III	**Multistage amplifiers** : Direct, RC, transformer coupled amplifiers – **Power amplifiers using BJT** : Class A, Class B and Class AB and class C- Conversion efficiency and distortion in power amplifiers. **Feedback Amplifiers**- Effect of positive and negative feedbacks- Basic feedback topologies and their properties	**8 hours**	15%
IV	**Oscillators** : Bark Hausen's criterion – RC oscillators (RC Phase shift oscillator and Wein Bridge oscillator) –LC oscillators (Hartley and Colpitt's)- Derivation of frequency of oscillation for the above mentioned oscillators- Crystal oscillator.	**8 hours**	15%

	Operational Amplifiers: Review of Operational Amplifier basics - Analysis of fundamental differential amplifier- Properties of ideal and practical Op-Amp - Gain, CMRR and Slew rate of IC 741 and LM 301– Drift and frequency compensation in OP Amps- Open loop and Closed loop Configurations-Concept of virtual short and its relation to negative feedback		
SECOND INTERNAL EXAMINATION			
V	**OP-AMP Circuits** : Review of inverting and non-inverting amplifier circuits- Summing and difference amplifiers, Differentiator and Integrator circuits- Logarithmic amplifier- Half Wave Precision rectifier - Instrumentation amplifier. Comparators: Zero crossing and voltage level detectors, Schmitt trigger.	8hours	20%
VI	**Wave form generation using Op-Amps**: Square, triangular and ramp generator circuits using Op-Amp - Effect of slew rate on waveform generation. **Timer 555 IC** : Internal diagram of 555 IC– Astable and Monostable multivibrators using 555 IC. **Oscillator circuits using Op-amps** : RC Phase shift oscillator, Wein Bridge oscillator, LC Oscillators- (Derivation not required) - Crystal oscillator.	8 hours	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV

Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI

Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE204	Digital Electronics and Logic Design	2-1-0-3	2016

Prerequisite : Nil

Course Objectives

To impart knowledge about digital logic and to gain the ability to design various digital circuits

Syllabus

Review of Number Systems and Codes, Digital Logic, Combinational Logic Circuits, Data Processing Circuits, Arithmetic Circuits, Flip-Flops, Registers, Counters, DACs and ADCs, Design of synchronous Sequential Circuits, Introduction to HDL.

Expected outcome.

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

1. Familiar with various number systems and Boolean algebra
2. design and analyse any digital logic gate circuits and Flip flop based systems.
3. Familiar with combinational circuits
4. gain the capability of implementing various counters,
5. describe the operation of ADC and DAC circuits
6. acquire basic knowledge on VHDL

Text Book:

1. Floyd T.L, Digital Fundamentals , 10/e, Pearson Education, 2011

2. C.H.Roth and L.L.Kimney Fundamentals of Logic Design, 7/e, Cengage Learning, 2013

References:

1. Donald P Leach, Albert Paul Malvino and GoutamSaha., Digital Principles and Applications, 8/e, by Mc Graw Hill
2. Mano M.M, Logic and Computer Design Fundamentals, 4/e, , Pearson Education.
3. Tocci R.J and N.S.Widmer, Digital Systems, Principles and Applications, 11/e, , Pearson Education.
4. John F. Wakerly, Digital Design: Principles and Practices, 4/e, , Pearson, 2005
5. Taub & Schilling: Digital Integrated Electronics, McGraw Hill,1997

Data Book (Approved for use in the examination):Nil

Course Plan			
Module	**Contents**	**Hours**	**Sem.ExamMarks**
I	Number Systems and Codes : Binary, Octal and hexadecimal conversions- ASCII code, Excess -3 code, Gray code, Error detection and correction - Parity generators and checkers – Fixed point and floating point arithmetic. Binary addition and subtraction, unsigned and signed numbers, 1's complement and 2's complement arithmetic.	**7 hours**	15%
II	TTL logic and CMOS logic - Logic gates, Universal gates - Boolean Laws and theorems, Sum of Products method, Product of Sum method – K map representation and simplification(upto four variables) - Pairs, Quads, Octets, Dont care conditions.	**7 hours**	15%
FIRST INTERNAL EXAMINATION			
III	Combinational circuits: Adders _ Full adder and half adder – Subtractors, halfsubtractor and fullsubtractor – Carry Look ahead adders – ALU(block diagram only). Multiplexers, Demultiplexers, Encoders, BCD to decimel decoders.	**7 hours**	15%
IV	Sequential circuits: Flip-Flops, SR, JK, D and T flip-flops, JK Master Slave Flip-flop, Conversion of flip-flops, Registers -SISO,SIPO, PISO, PIPO. Counters : Asynchronous Counters – Modulus of a counter – Mod N counters.	**8 hours**	15%
SECOND INTERNAL EXAMINATION			
V	Synchronous counters: Preset and clear modes, Counter Synthesis: Ring counter, Johnson Counter, Mod N counter, Decade counter. State Machines: State transition diagram, Moore and Mealy Machines – Design equation and circuit diagram.	**7 hours**	20%
VI	Digital to Analog conversion – R-2R ladder, weighted resistors. Analog to Digital Conversion - Flash ADC, Successive approximation, Integrating ADC.	**8 hours**	20%

	Memory Basics, Read and Write, Addressing, ROMs, PROMs and EPROMs, RAMs, Sequential Programmable Logic Devices - PAL, PLA, FPGA (Introduction and basic concepts only) Introduction to VHDL, Implementation of AND, OR, half adder and full adder.		
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV

Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI

Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE205	DC MACHINES AND TRANSFORMERS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

To give exposure to the students about the concepts of direct current machines and transformers, including their constructional details, principle of operation and performance analysis.

Syllabus:

Electromagnetic principles for Machines, electrodynamic equations and their solution, Magnetic Circuits for Machines, construction of DC machines, DC generators, DC motor, Transformers - single phase and three phase, Construction of single phase and three phase transformers, losses and efficiency, equivalent circuit, testing. Transformer connections.

Expected outcome.

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

1. identify dc generator types, and appreciate their performance
2. describe the principle of operation of dc motor and select appropriate motor types for different applications.
3. analyse the performance of different types of dc motors
4. describe the principle of operation of single phase transformers
5. analyse the performance of single phase transformers
6. familiarize with the principle of operation and performance of three phase ransformers.

Text Book

1. Bimbra P. S., *Electrical Machinery*, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D. P. Kothari, *Theory of AC Machines*, Tata McGraw Hill, 2006.

Reference Books

1. Fitzgerald A. E., C. Kingsley and S. Umans, *Electric Machinery*, 5/e, McGraw Hill, 1990.
2. Langsdorf M. N., *Theory of Alternating Current Machinery*, Tata McGraw Hill, 2001.
3. Abhijith Chakrabarti, Sudipta Debnath, Electrical Machines, McGraw Hill Education, New Delhi 2015.
4. Deshpande M. V., *Electrical Machines*, Prentice Hall India, New Delhi, 2011.
5. Theodore Wilde, *Electrical Machines, Drives and Power System*, Pearson Ed. Asia 2001.

Data Book (Approved for use in the examination): Nil

Course Plan

Module	Contents	Hours	Semester Exam Marks
I	Electromagnetic principles for Machines Electro dynamical equations and their solution – rotational motion system – mutually coupled coils – construction of DC machines – energy conversion in rotating electrical machines – eddy currents and eddy current losses – flux distribution curve in the airgap – armature windings – lap and wave windings – selection criteria – equalizer rings – dummy coils.	9 hours	15%
II	DC generators – EMF equation – methods of excitation – separately and self excited – shunt, series, compound – armature reaction – effects of armature reaction – demagnetizing & cross magnetizing ampere-turns – compensating windings – interpoles – commutation – methods to improve commutation – voltage build-up – no load	9 hours	15%

	characteristics – load characteristics – losses and efficiency – power flow diagram – parallel operation – applications of dc generators.		
FIRST INTERNAL EXAMINATION			
III	DC motor – principle of operation – back emf – classification – torque equation – losses and efficiency – power flow diagram – performance characteristics of shunt, series and compound motors – starting of dc motors – necessity and types of starters – speed control – methods of speed control – testing – Swinburne's test – Hopkinson's test – separation of losses – retardation test – applications of dc motors.	9 hours	15%
IV	Transformers – principle of operation – types and construction, core type and shell type construction, dry type transformers, cooling of transformers – ideal transformer – transformation ratio – dot convention – polarity test – practical transformer – kVA rating – equivalent circuit – phasor diagram.	9 hours	15%
SECOND INTERNAL EXAMINATION			
V	Transformer losses and efficiency – voltage regulation – OC & SC test – Sumpner's test – all day efficiency Autotransformer – saving of copper – current rating and kVA rating of autotransformers, parallel operation of single phase transformers, necessary and desirable conditions of parallel operation, on load and off load tap changers.	9 hours	20%
VI	3-phase transformer – 3-phase transformer connections – Δ-Δ, Y-Y , Δ-Y , Y-Δ, V-V – vector groupings Yy0, Dd0, Yd1, Yd11, Dy1, Dy11 – Scott connection – three winding transformer – tertiary winding – percentage and per unit impedance – parallel operation of three phase transformers.	9 hours	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV
Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI
Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE206	MATERIAL SCIENCE	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

To impart knowledge in the field of material science and their applications in electrical engineering

Syllabus:

Conducting materials- properties-applications- Semi conductor materials- properties-applications-Magnetic materials-classification-alloys of iron-ferrites-Dielectric materials-polarization-solid, liquid and gaseous insulators-Dielectric breakdown-superconductors-solar energy materials-Spectroscopy-micropscopy-magnetic resonance-nanomaterials

Expected Outcome:

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

1. Describe the characteristics of conducting and semiconducting materials
2. Classify magnetic materials and describe different laws related to them
3. Classify and describe different insulators and to explain the behaviour of dielectrics in static and alternating fields
4. Describe the mechanisms of breakdown in solids, liquids and gases
5. Classify and describe Solar energy materials and superconducting materials
6. Gain knowledge in the modern techniques for material studies

Text Book:

1. Dekker A.J : Electrical Engineering Materials, Prentice Hall of India
2. G K Mithal : Electrical Engg Material Science. Khanna Publishers.

References:

1. Tareev, Electrical Engineerin Materials, Mir Publications
2. Meinal A.B and Meinal M. P., Applied Solar Energy – An Introduction, Addisos Wesley
3. Nasser E., *Fundamentals of Gaseous Ionization and Plasma Electronics*, Wiley Series in Plasma Physics, 1971
4. Naidu M. S. and V. Kamaraju, *High Voltage Engineering*, Tata McGraw Hill, 2004
5. Indulkar O.S &Thiruvegadam S., An Introduction to electrical Engineering Materials, S. Chand
6. Agnihotri O. P and Gupta B. K, Solar selective Surface, John wiley
7. Seth. S.P and Gupta P. V, A Course in Electrical Engineering Materials, Dhanpathrai

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Conducting Materials: Conductivity- dependence on temperature and composition – Materials for electrical applications such as resistance, machines, solders etc. Semiconductor Materials: Concept, materials and properties- – Basic ideas of Compound semiconductors, amorphous and organic semiconductors- applications. Dielectrics: Introduction to Dielectric polarization and classification –Clausius Mosotti relation- Behavior of dielectric in static and alternating fields	8	15%
II	Insulating materials and classification- properties- Common insulating materials used in electrical apparatus-Inorganic,	6	15%

	organic, liquid and gaseous insulators- capacitor materials- Electro-negative gases- properties and application of SF6 gas and its mixtures with nitrogen Ferro electricity.		
FIRST INTERNAL EXAMINATION			
III	Dielectric Breakdown: Mechanism of breakdown in gases, liquids and solids –basic theories including Townsend's criterion, Streamer mechanism, suspended particle theory, intrinsic breakdown, electro-mechanical breakdown- Factors influencing Ageing of insulators- Application of vacuum insulation- Breakdown in high vacuum-Basics of treatment and testing of transformer oil .	7	15%
IV	Magnetic Materials: Origin of permanent magnetic dipoles- Classification of magnetic materials -Curie-Weiss law- Properties and application of iron, alloys of iron- Hard and soft magnetic materials– Ferrites- Magnetic materials used in electrical machines, instruments and relays-	7	15%
SECOND INTERNAL EXAMINATION			
V	Superconductor Materials:-Basic Concept- types- characteristics-applications Solar Energy Materials: Photo thermal conversion- Solar selective coatings for enhanced solar thermal energy collection –Photovoltaic conversion – Solar cells -Silicon, Cadmium sulphide and Gallium arsenic – Organic solar cells.	7	20%
VI	Modern Techniques for materials studies: Optical microscopy – Electron microscopy – Photo electron spectroscopy – Atomic absorption spectroscopy – Introduction to Biomaterials and Nanomaterials	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV.
Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI.
Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE207	COMPUTER PROGRAMMING	2-1-0-3	2016

Course Objectives

To impart knowledge about programming in C

To learn basics of PYTHON.

Syllabus Introduction to Programming, Basic elements of C, Control statements in C, Arrays and Strings, Functions, Storage classes ,Structures and Pointers, File Management in C, Introduction to Python

Expected outcome. 1. Ability to design programs using C language
2. Ability to develop simple programs using Python

Text Book:1)E. Balaguruswamy, *Programming in ANSI C*, Tata McGraw Hill, New Delhi
2) John V Guttag, Introduction to Computation and programming using Python, PHI Learning, New Delhi.

Data Book (Approved for use in the examination): Nil

References:

1. P. Norton, *Peter Norton's Introduction to Computers*, Tata McGraw Hill, New Delhi
2. Byron S. Gottfried, Programming with C, Schaun Outlines –McGraw Hill.
3. Ashok Kamthane, Programming with ANSI & Turbo C- Pearson education
4. K.R Venugopal and S.R Prasad, Mastering C - Tata McGraw Hill
5. Kelley, Al & Pohl, *A Book on C- Programming in C*, 4th Ed,, Pearson Education

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	**Introduction to Programming**: Machine language, assembly language, and high level language. Compilers and assemblers. Flow chart and algorithm – Development of algorithms for simple problems. **Basic elements of C:** Structure of C program –Keywords, Identifiers, data types, Operators and expressions – Input and Output functions	5hours	15%
II	**Control statements in C:** *if, if-else, while, do-while and for statements, switch, break, continue, go to, and labels. Programming examples.*	7 hours	15%
	FIRST INTERNAL EXAMINATION		
III	**Arrays and Strings**: Declaration, initialisation, processing arrays and strings– two dimensional and multidimensional arrays –application of arrays. Example programs.	7 hours	15%
IV	**Functions :** Functions – declaring, defining, and accessing functions –parameter passing methods – – passing arrays to functions , Recursion . **Storage classes** – extern, auto, register and static. Example programs.	7 hours	15%
	SECOND INTERNAL EXAMINATION		

V	**Structures** – declaration, definition and initialization of structures, unions **Pointers**: Concepts, declaration, initialization of pointer variables, Accessing a Variable through its Pointer Chain of Pointers, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and Arrays, examples	**8 hours**	20%
VI	**File Management** – File operations, Input/Output Operations on Files, Random Access to Files ,File pointer. **Introduction to Python** :Basic Syntax, Operators, control statements, functions-examples.	**8hours**	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV

Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI

Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
EE208	MEASUREMENTS AND INSTRUMENTATION	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

To develop understanding of various electrical measuring instruments and instrumentation devices

Syllabus

Measurements standards, errors in measurements, operating torques, classification of electrical meters, Measurement of voltage, current, resistance, power, energy, high voltage and high currents. Magnetic measurements, ac potentiometers, ac bridges, CRO, Transducers

Expected Outcomes:

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

1. Compare different types of instruments-their working principles, advantages and disadvantages.
2. Explain the operating principles of various ammeters, voltmeters and ohm meters
3. Describe wattmetrs and energy meters
4. Describe different flux and permeability measurements methods
5. Identify different AC potentiometers and bridges,
6. Understand the working and applications of cathode ray oscilloscope
7. Identify the transducers for physical variables and to describe operating principle

Text Book:

1. Sawhney A.K., A course in Electrical and Electronic Measurements & instrumentation, DhanpatRai .
2. J. B. Gupta, A course in Electrical & Electronic Measurement & Instrumentation., S K Kataria& Sons
3. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012

References:

1. Golding E.W., Electrical Measurements & Measuring Instruments, Wheeler Pub.
2. Cooper W.D., Modern Electronics Instrumentation, Prentice Hall of India
3. Stout M.B., Basic Electrical Measurements, Prentice Hall
4. Oliver & Cage, Electronic Measurements & Instrumentation, McGraw Hill
5. E.O Doebelin and D.N Manik, Doebelin's Measurements Systems, sixth edition, McGraw Hill Education (India) Pvt. Ltd.
6. P.Purkait, B.Biswas, S.Das and C. Koley, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education (India) Pvt. Ltd.,2013

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	General principles of measurements – measurement system-measurement standards – characteristics - errors in measurement-calibration of meters- significance of IS standards of Instruments. Classification of meters - operating forces - essentials of indicating instruments - deflecting, damping, controlling torques. Ammeters and voltmeters - moving coil, moving iron, constructional details and operating, principles shunts and multipliers – extension of range.	9	15%
II	Measurement of resistance: measurement of insulation resistance - loss of charge method, measurement of earth resistance. Measurement of power and energy: Dynamometer type wattmeter – 1-phase and 3-phase power measurement – 1-phase and 3-phase energy meters (induction type) – electronic energy meter, TOD meter.	10	15%

FIRST INTERNAL EXAMINATION			
III	Introduction to high voltage and high current measurements: Measurement of high DC voltages - measurement of high AC voltages - electrostatic voltmeters – sphere gaps - DC Hall effect sensors - high current measurements. Study of Phasor Measurement Units (PMU). Current transformers and potential transformers – principle working, ratio and phase angle errors – numerical problems, Clamp on meters.	9	15%
IV	Magnetic Measurements: Measurement of flux and permeability - flux meter - hall effect Gaussmeter - BH curve and permeability measurement - hysteresis measurement- ballistic galvanometer – principle- determination of BH curve - hysteresis loop. Lloyd Fisher square — measurement of iron losses Measurement of rotational speed using proximity sensors and optical sensors.	9	15%
SECOND INTERNAL EXAMINATION			
V	DC & AC potentiometers - General Principle - calibration of ammeter, voltmeter and wattmeter using potentiometer. AC Bridges: Maxwell's bridge- Schering bridge and Wien's bridge Oscilloscopes – Basic principle of signal display - Block diagram and principle of operation of general purpose CRO - vertical deflecting system - horizontal deflection system - basic sweep generator - XY mode and Lissajous patterns - applications of CRO - dual trace oscilloscope. digital storage oscilloscope	9	20%
VI	Transducers - Definition and classification - common transducers for measurement of displacement, velocity, flow, liquid level, force, pressure, strain and temperature - basic principles and working of LVDT, electromagnetic and ultrasonic flow meters, piezoelectricforce transducer, load cell, strain gauge- bridge configuration for four strain gauges, RTD, Thermistors, thermocouple, Need for instrumentation system, data acquisition system.	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Part A: 8 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

Part C: 3 questions uniformly covering modules III&IV
Student has to answer any 2 questions: (2 x 10) =20

Part D: 3 questions uniformly covering modules V&VI
Student has to answer any 2 questions: (2 x 10) =20

Note: Each question can have maximum of 4 sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE209	Electrical Technology	3-1-0 -4	2016

Prerequisite : Nil

Course Objectives

- To understand about the network Elements, types of networks & analysis of complex circuits using Mesh current & Nodal voltage method.
- To impart knowledge on the solution methods of AC and DC circuits.
- To understand the working principle and characteristics of all electrical machines

Syllabus

Types of Networks- mesh current & Nodal voltage method for DC and AC circuits-Basics of Circuit theorems-AC circuits- RLC circuits- series and parallel resonance-Three phase circuits- Power measurements in three phase circuits-DC machines construction – working- EMF equation – Characteristics of DC shunt and series motor and generator-Starters- Concept of transformers-EMF equation- concept of rotating magnetic field- working principle of induction motors-special machines and their application.

Expected outcome.

i. Understand the circuit analysis and theorems.
ii. Understand the concept of three phase RLC circuits.
iii. Get knowledge in construction and working of dc machines
iv. Get knowledge in special machines and their applications.
v. Understand the construction and working of induction machines.

Text Book:

1. Theraja B.L., Theraja A.K. *A Text Book of Electrical Technology*, Vol.II "AC & DC Machines", publication division of Nirja construction & development (p) Ltd., New Delhi, 1994.

2. Sudhakar, A. and Shyam Mojan, S.P. *Circuits and Networks Analysis and Synthesis*, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1994.

References:

1. Raina K.B., Bhattacharya S.K. *Electrical Design Estimating & Costing*, New Age International P Ltd.,2001.

2. Muthusubramanian R & Ayyappan K, *Circuit Theory*, Anuradha Publishign Pvt Ltd., Tamil Nadu 1999.

3. Arumugam & Premkumar, *Electric Circuit Theory*, Khanna Publishers. 2002

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**BASICS OF CIRCUIT ANALYSIS** Types of Networks – Sources transformation – Star – Delta transformation – formation of matrix equation and analysis of circuits using mesh current & Nodal voltage method for DC and AC circuits.	10	15%
II	**BASICS OF CIRCUIT THEOREMS** Thevenin's theorem – Norton's theorem – superposition theorem – maximum power transfer theorem – statement, illustration & application to DC circuits.	9	15%

FIRST INTERNAL EXAMINATION			
III	**AC CIRCUITS:** Review of Basic concepts – solution of RLC circuit – power – power factor and energy relation – series resonance – parallel resonance – Q factor – bandwidth. Three phase star-delta connections – characteristic equations – phasor diagrams – solution of 3-phase balanced circuits & unbalanced circuits – Three phase power measurement suing watt meters	10	15%
IV	**DC MACHINES:** Review of constructional details – Working principle of DC generator – EMF equation – No load & load characteristics of shunt generator – working principle of DC motor – back emf – equations for torque & power – characteristics of shunt, series & compound motors – Necessity of starters and their types— power stages – efficiency.	9	15%
SECOND INTERNAL EXAMINATION			
V	**TRANSFORMERS** Construction – working principle – emf equation & voltage regulation – vector diagram **3-PHASE INDUCTION MOTORS** Production of rotating magnetic field – torque equation, torque – slip characteristics – power stages and efficiency – simple problems – starters & methods of speed control (quantitative treatment only).	10	20%
VI	**SPECIAL MACHINES / APPLICATIONS** (Qualitative treatment only) Working principle of single phase induction motor – capacitor start & capacitor run motors – Universal motor – stepper motor – servomotor - Synchronous motor Selection of motors with justifications for the following services, *Machine tools *Washing machine *Cranes *WetGrinder *Steel mills * Mixie *Hoist *Electric traction	9	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE212	ELECTRICAL TECHNOLOGY AND SAFETY	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To understand the concepts in the working of electrical generator, motor, and transformer .
- To learn the basic function of electrical switch gear.
- To make the students acquire a sound knowledge in fundamentals of electrical safety
- To impart some fundamentals about the safety provisions in Indian Electricity Act and Rules.

Syllabus

Construction and Principle of operation of DC Generator - Dc motor - Induction motor – Alternator - Synchronous motor –Transformer - Protective Relays -Types -Circuit breaker - Arc phenomenon - Protection against over voltages –Lightning –Grounding -Types. Electric shock - effects and its prevention - Safety during installation of plant and equipment - Hazardous zone - Electrical safety in Residential, Commercial and Agricultural Installations - Hazards of static electricity - Safety provisions in Indian Electricity act and Rules.

Expected outcome

- At the end of this course, the students will have exposed to fundamentals of electrical machines and gained idea about electrical safety.

References

- V.K Mehta, Rohit Mehta. "Principles of Electrical Machines". S Chand Publishers
- W.Fordham Cooper. "Electrical safety Engineering" Butterworth and company London
- S.L. Uppal : A Textbook of Electrical Engineering, Khanna Publishers, Delhi
- H. Cotton : Electrical Technology, Wheeler Publishing Company
- Indian Electricity Act and Rules, Government of India.
- S. Rao, and H.L. Saluja : Electrical Safety, Fire Engineering and Safety Management, Khanna Publishers, Delhi
- M.G. Say : Electrical Earthing and Accident prevention, Newnes, London, 1954
- V.K Mehta, Rohit Mehta. "Principles of Power System".S Chand Publishers
- *Accident Prevention Manual for Industrial Operations* : National Safety Council, Chicago.
- www.osha.gov

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Construction and Principle of operation of d.c machines – e.m.f equation of a generator – Types of dc generator – losses – Condition for maximum efficiency–Armature Reaction– Compensating winding-characteristics of shunt, series and compound generators –Critical field resistance and critical speed– Parallel operation. Dc Motor Characteristics–speed control.	6	15%
II	Synchronous machines – types – e.m.f equation – winding factors – armature reaction and leakage resistance. Synchronous motor – methods of starting – applications. Induction Motors –		15%

	Construction and principle of operation – equivalent circuit – Torque – slip characteristics – method of starting – applications.	7	
FIRST INTERNAL EXAMINATION			
III	Construction and Principle of operation of single phase transformers – e.m.f equation – phase diagrams – equivalent circuit–Tests–regulation – losses and efficiency. Protective relays – Requirement of relay – types of protection – classification – distance relay, differential relay, state relays.	7	15%
IV	Circuit breakers – function of switch gear – arc phenomenon – initialization of an arc– Methods of Arc Extinction–Types–Arc voltage –restriking voltage and recovery voltage. Fuses – Characteristics– types –selection – advantages and disadvantages – MCB and ELCB. Faults in power systems – causes – types. Protection against over voltages– causes–Lightning–Lightning arrester.	7	15%
SECOND INTERNAL EXAMINATION			
V	Grounding – neutral grounding – solid grounding – resistance grounding – arc suppression coil grounding. Equipment grounding for safety – Human safety aspects – effect of current and voltage on human beings – typical V-I characteristics of skin – Electric shocks and their prevention– Medical Analysis of shock. Insulation – classes of insulation – FRLS insulation – continuity test.	7	20%
VI	Safety during installation of plant and equipment. Safe sequences in installation – risk during installation. Safety during testing and commissioning. Test on relays – protection and interlock systems for safety. Hazardous zones – classification of hazardous zones. Fire prevention and fire fighting in power stations, Substations-causes of initiation of fire-Fire Extinguishing Techniques. Electrical safety in Residential, Commercial and Agricultural Installations – Case study. Hazards of static electricity. Safety provisions in Indian Electricity Act & Rules.	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Duration: 3 Hours

Part – A: 5 MARK QUESTIONS

There will be two questions from module 2 and module 3 and one question each from remaining modules (8x5 = 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions

(3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
EE214	ELECTRICAL TECHNOLOGY AND INSTRUMENTATION	3-0-0-3	2016

Prerequisites: Nil

Course Objectives:

- To impart understanding of the basic working principles of DC and AC machines.
- To impart understanding of the basic principles of instrumentation and its applications.

Syllabus:

DC Generator- Load Characteristics; DC Motors- Speed & Torque, Performance Characteristics; 3ph Induction Motors-Torque Equation, Characteristics; Alternators- Construction; Regulation- Transformers, Regulation Efficiency; Instrumentation- Calibration, Errors; Transducer Classification.

Expected Outcome:

Upon successful completion of the course, the student will be able to:

i. Understand the basic working principle, construction, types, performance characteristics and applications of DC generators, DC motors and induction motors.
ii. Understand the basic working principle, construction, types, EMF equation, voltage regulation, EMF, MMF methods to determine the voltage regulation of alternators.
iii. Understand the basic working principle, construction, types, equivalent circuit, losses, efficiency, regulation and applications of transformers and predetermine their efficiency by conducting OC and SC.
iv. Understand the basic principles of instrumentation, measurement standards and types of errors in instruments and measurements and its applications.

Text Books:

- Dr. P. S. Bimbra; Electrical Machinery; Khanna Publishers.
- J. B. Gupta; Theory and principles of Electrical Machines; S. K.Kataria and Sons Tex.

Reference Books:

- A.K.Sawhney; Electrical and Electronic Measurements and Instrumentation; DhanpatRai.
- Alexander Langsdorf A. S.; Theory of AC Machinery; Mc-Graw Hill.
- James.W.Dally, William.F. Riley, Kenneth G. McConnell; Instrumentation for Engineering Measurement.
- Say M.G.; Performance and Design of AC Machines; ELBS.
- William D. Cooper, A.D. Helfrick; Electronic Instrumentation and Measurement Techniques; Prentice Hall.

Course Plan

Module	Content	Hours	Sem. Exam Marks
I	**D.C. Generator:** O.C.C. ; Condition for Self Excitation; Field Critical Resistance; Critical Speed; Load Characteristics of	7	15%

	Generators; *Losses*; Power Flow Diagram; Efficiency, Condition for Maximum Efficiency; *Applications*.		
II	**D.C. Motors:** Back EMF; Speed and Torque Equation; Starting, Testing of D.C. Motors, Brake Test; Swinburne's Test; Performance and operating characteristics of Shunt, Series and Compound Motors; *Applications.*	7	15%
FIRST INTERNAL EXAM			
III	**Three Phase Induction Motor**: Production of Rotating Magnetic Field; Torque Equation; Torque Slip Characteristics, Equivalent Circuit; *Application*. Single Phase Induction Motor: Different Types; *Application.*	7	15%
IV	**Alternators**: *Construction Details*, Type; EMF Equation (Winding Factor need not be derived); Synchronous Impedance; Regulation by EMF and MMF Method.	7	15%
SECOND INTERNAL EXAM			
V	**Transformer**: *Construction*, *Working*, *Types*, EMF Equation, No Load Current; Equivalent Circuit; Phasor Diagram, Regulation, Efficiency, Determination of Regulation and Efficiency from O.C. and S.C. tests; *Cooling of Transformer*; Applications.	7	20%
VI	**Introduction to Instrumentation and its Applications:** Classification of Instruments; Standards and Calibration; Errors in Instruments and Measurements; Classification of Transducers; Strain Gauges; *L.V.D.T. (Linear Variable Differential Transformer)*, Mc.Leod Gauge, Pirani Gauge, Hot-wire Anemometers; Constant Temperature and Constant Current Methods.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 full questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each full question can have maximum of 4 sub questions, if needed.

Course code	Course name	L-T-P-Credits	Year Of Introduction
EE216	ELECTRICAL ENGINEERING	3-0-0-3	2016

Prerequisite : Nil

Course objectives

To introduce the fundamental concepts of transformer, alternator, DC machine, induction motor and indicating instruments

Syllabus

Transformers- Principle of operation & different types, DC generator, DC Motor, Alternators in detail, Concepts of three phase Induction motor and types, Principle of Indicating instruments.

Expected outcome

The students will

i. Get the basic idea of Electrical engineering.
ii. Be able to differentiate between the types of motors and transformers
iii. gain information about the function of various measuring instruments and using them

Text Books

1. E. Hughes, Electrical & Electronic Technology, 8th ed., Pearson Education, Delhi, 2002.
2. B.L. Theraja and A.K. Theraja, AC and DC machines Volume II

Reference books

1. Del Toro V, Electrical engineering fundamentals, 2/e. Prentice Hall India. Eastern Economy Edition. 1998.
2. E. W. Golding and F. G. Widdis, Electrical Measurements and Measuring Instruments, 5th ed., AH Wheeler & Company, Calcutta, 1993.
3. H. Cotton, Advanced Electrical Technology, Sir Isaac Pitman and Sons, London, 1974

Course Plan

Module	Contents	Hours	Semester Exam Marks
I	Transformers- Principle of operation - emf equation - Phasor diagram - Equivalent circuit - OC and SC tests – Basic principles of auto transformer and three phase transformer	5	15%
II	DC Generator – E.M.F equation- Armature reaction – Commutation - interlopes – power flow diagram – losses and efficiency – voltage regulation – parallel operation – load sharing	8	15%
	FIRST INTERNAL EXAMINATION		
III	DC Motor- back E.M.F. – speed equation – torques – performance characteristics – power flow diagram losses and efficiency – starter- two point and three point – swinburns test – thyristor control of series and shunt motor.	8	15%
IV	Alternator- Rotating field - Frequency effect of distribution of winding - emf equation – Basic principles of	6	15%

	synchronous motor – Losses and Efficiency - Torque equation - Starting methods - induction motor - Constructional features - Principle of operation of 3 phase induction motor – Vector diagram and equivalent circuits - Starting and speed control of squirrel cage and wound rotor induction motor		
SECOND INTERNAL EXAMINATION			
V	Three phase Induction motor- types – torque equations- torque slip and torque speed characteristics- power flow diagram – efficiency – equivalent circuit- induction generator Special machines – single phase FHP motor starting methods- double field revolving theory-types and applications – stepper motor –classifications and applications – servomotors – classifications and applications –shaded pole motors –applications	6	20%
VI	Principle of Indicating instruments- moving coil, moving iron and dynamometer type instruments- Extension of range of voltmeter and ammeter - Measurement of 3 phase power by two wattmeter method – Principle and working of Induction type energy meter- DC slide wire, potentiometer.	9	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A
Answer any two out of three questions uniformly covering Modules 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions
(15 x 2 = 30 marks)

Part B
Answer any two out of three questions uniformly covering Modules 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions.
(15 x 2 = 30 marks)

Part C
Answer any two out of three questions uniformly covering Modules 5 and 6 together. Each question carries 20 marks and may have not more than four sub divisions.
(20 x 2 = 40 marks)

Course No.	Course Name	L-T-P - Credits	Year of Introduction
EE231	ELECTRONIC CIRCUITS LAB	0-0-3-1	2016

Course Objectives

To design and develop various electronic circuits using discrete components and OPAMPs.

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

1.Study & Use of CRO: Measurement of current voltage, frequency and phase shift.
2.Half wave and Full wave (Centre-tapped and bridge) Rectifiers with and without filters- Calculation of Ripple factor, Rectification efficiency, and % regulation.
3. Clipping circuits using diodes
4. Clamping circuits using diodes
5. RC coupled amplifier using BJT in CE configuration- Measurement of gain, input and output impedance and frequency response
6. JFET amplifier- Measurement of voltage gain, current gain, input and output impedance
7.Design and testing of simple zener voltage regulators
8.OPAMP circuits – Design and set up of inverting and non-inverting amplifier, scale changer, adder, integrator, differentiator
9. Precision rectifier using Op-amps
10.Phase shift oscillator using OPAMPs.
11.Wein's Bridge oscillator using OPAMPs.
12.Waveform generation – Square, triangular and sawtooth wave form generation using OPAMPs.
13. Basic comparator and schmitt trigger circuits using Op-amp
14. Design and testing of series voltage regulator using zener diode
15. Astable and monostable circuit using 555 IC
16. RC phase shift oscillator using BJT
17.Introduction to circuit simulation using any circuit simulation software.
18. Introduction to PCB layout software

Expected outcome.

The student should be able to design and implement various electronic circuits using BJTs and OPAMPs.

Text Book/References:

1. Malvino A. and D. J. Bates, Electronic Principles 7/e, Tata McGraw Hill, 2010.
2. Boylestad R. L. and L. Nashelsky, Electronic Devices and Circuit Theory, 10/e, Pearson Education India, 2009.
3. Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.
4. Millman J. and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw-Hill, 2010.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
EE232	Electrical Machines Lab - I	0-0-3-1	2016

Course Objectives

To learn the working and testing methods of DC machines and transformers.

List of Exercises/Experiments:

Part A – DC Machines

1. Open circuit characteristics of DC shunt generator
   Objectives:
   a) Predetermine the OCC at different speeds
   b) Determine the critical field resistance
   c) Obtain maximum voltage built up with given shunt field resistance
   d) Obtain critical speed for a given shunt field resistance
2. Load test on DC shunt generator
   Objectives:
   a) Determine the external & internal characteristics
   b) Deduce the armature reaction curve
3. Load test on DC compound generator
   Objectives:
   a) Determine the external characteristics cumulative compound condition
   b) Determine the external characteristics differential compound condition
4. Brake test on DC shunt motor
   Objectives:
   Plot the following characteristics
   i) Efficiency Vs Output
   ii) Line current Vs Output
   iii) Speed Vs Output
   iv) Speed Vs Torque
   v) Line current Vs Torque
5. Brake test on DC series motor
   Objectives:
   Plot the following characteristics
   i) Efficiency Vs Output
   ii) Line current Vs Output
   iii) Speed Vs Output
   iv) Speed Vs Torque
   v) Line current Vs Torque
6. Swinburne's test on a DC shunt machine
   Objectives:
   Predetermine the armature current and percentage efficiency when the machine operates as a motor and as a generator for various load conditions and plot efficiency Vs output curves.
7. Hopkinson's test on a pair of DC machines
   Objectives:
   Determination of the efficiency of the given dc shunt machine working as a motor and

generator
under various load conditions.

8. Retardation test on a DC machine

Objectives:

a) Separation of hysteresis, eddy current, friction &windage losses
b) Find the moment of inertia of the rotating system

9. Separation of losses in a DC shunt motor

Objectives:

a) Separation of hysteresis, eddy current, friction &windage losses
b) Plot the losses vs speed curves

Part B – Transformers

10. O.C. & S.C. tests on the single phase transformer

Objectives:

Predetermination of the following

a) Efficiency at different load conditions and different power factors
b) Regulation at different load conditions and different power factors
c) Equivalent circuit referred to HV and LV sides
d) UPF load at which efficiency is maximum
e) Power factors at which regulation is maximum and zero
f) Regulation vs. power factor curves

11. Load test on the single phase transformer

Objectives:

a) Determination of the efficiency at different load conditions and unity power factor
b) Determination of the regulation at different load conditions and unity power factor
c) Plot efficient vs. output & regulation Vs output curves

12. Separation of losses in a single phase transformer

Objectives:

Separate the hysteresis & eddy current losses at different voltages & different frequencies keepingV/f constant & plot losses vs. frequency curves. Hence

i) Separate the hysteresis & eddy current losses at normal voltage & different frequencies &
plot losses vs. frequency curves
ii) Separate the hysteresis & eddy current losses at normal frequency & different voltages &
plot losses vs. voltage curves.

13. Sumpner's test

Objective:

a) Predetermination of efficiency at different load conditions and power factors
b) Predetermination of regulation at different load conditions and power factors
c) Plot efficiency vs. output & regulation vs. power factor curves
d) Obtain the equivalent circuit referred to LV & HV sides

14. Scott connection of single phase transformers

Objectives:

Determine the efficiency at different load conditions when

a) Main transformer alone loaded
b) Teaser transformer along loaded
c) both transformers loaded under balanced conditions
d) both transformers loaded under unbalanced conditions
e) Plot efficiency vs. output curves for each case.

15. Parallel operation of single phase transformers

Objectives:

a) To determine the load sharing of each transformer by their equivalent impedances

b) To verify the load sharing by actual measurements

16. Three phase connection of single phase transformers

Objectives:

a) Determine the polarity of single phase transformers

b) Connect three single phase transformers in star-star configuration

c) Connect three single phase transformers in star-delta configuration

d) Determine the transformation ration in the above cases

17. O.C. & S.C. tests on the Three phase transformer

Objectives:

Predetermination of the following

a) Efficiency at different load conditions and different power factors

b) Regulation at different load conditions and different power factors

c) Equivalent circuit referred to HV and LV sides

18. Load Test on V connected Transformers

Objectives:

Connect two single phase transformers in V-V connection and conduct a load test to plot the efficiency curve.

Out of the above experiments, minimum twelve experiments should be done in lab taking at least six experiments from both Part A and Part B.

Expected outcome:

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

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

1. Analyse the characteristics of different dc generators
2. Separate the losses in dc motors
3. Analyse the performance of different types of dc motors
4. Determine the performance characteristics of single phase transformers
5. Compare the performance of transformers in different modes of operations and connections

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 No.	Course Name	L-T-P - Credits	Year of Introduction
EE233	PROGRAMMING LAB	0-0-3-1	2016

Course Objectives

To impart knowledge and develop skills in programming

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

1. At least four simple programs using input output statements (example: area of rectangle, circle, etc)
2. At least four Simple programs using decision statements (Example: Even or odd, pass or fail)
3. At least four Programs using Control statements and decision statements (Example maximum, minimum of a given set of numbers, hcf, lcm)
4. Program to add n numbers
5. Programs to print patterns
6. Program to check whether a number is prime
7. program to generate Fibonaacii series
8. Array manipulation (searching, insertion and sorting)
9. Few programs using pointers
10. Functions Pass by value Pass by reference
11. Recursive functions (example: Fibonaacii series and factorial)
12. String manipulation – compare, copy, reverse operations
13. Matrix operations: addition multiplication, determinant and inverse
14. Reading from a file and writing to a file Merging and appending of files.
15. Solution of algebraic and transcendental equations: Bisection, Newton- Raphson method- comparison
16. Introductory programs using Python
17. Function calls in Python

Expected outcome. 1. Ability to design programs using C language
2. Ability to develop simple programs using Python

References:

1. E. Balaguruswamy, *Programming in ANSI C*, Tata McGraw Hill, New Delhi
2. Kernighan, Brian W., and Dennis M. Ritchie. *The C programming language*. Vol. 2. Englewood Cliffs: prentice-Hall, 1988.
3. Introduction to computation and programming using Python, John V. Guttag, PHI Learning, New Delhi
4. Downey, Allen, Jeffrey Elkner, and Chris Meyers. *How to think like a computer scientist: learning with python*. John Wiley 2015.
5. Lambert, Kenneth. Fundamentals of Python: first programs. Cengage Learning, 2011.

Course No.	Course Name	L-T-P - Credits	Year of Introduction
EE234	CIRCUITS AND MEASUREMENTS LAB	0-0-3-1	2016

Course Objectives

To develop measurement systems for various electrical circuits and systems and to use different transducers for measurement of physical variables.

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

1. Verification of Superposition Theorem in dc circuits.
2. Verification of Thevenin's Theorem in dc circuits.
3. Determination of impedance, admittance, power factor and real/reactive/ apparent power drawn in RLC series/parallel circuits.
4. 3-phase power measurement using one wattmeter and two-wattmeter method.
5. Determination of B-H curve, μ-H curve and μ-B curve of an iron ring specimen.
6. Measurement of voltmeter and ammeter resistances using Wheatstone's bridge and Kelvin's double bridge and extension of range of voltmeters and ammeters
7. Measurement of self/ mutual inductance and coupling co-efficient of iron cored coil and air-cored coil.
8. Calibration of meters and measurement of unknown resistance using slide- wire potentiometer.
9. Calibration of single phase energy meter by direct and phantom loading at various power factors.
10. Calibration of 3-phase energy meter using standard wattmeter.
11. Calibration of wattmeter using Vernier dial potentiometer
12. Measurement of capacitance using Schering Bridge.
13. Extension of instrument range by using Instrument transformers(CT and PT)
14. Characteristics of Thermistor, RTD, and Thermocouple
15. Characteristics of LVDT.
16. Characteristics of strain gauge/ Load cell.
17. Measurement of energy using electronic Energy meter/TOD meter
18. Current measurement using Clamp on meter

Expected Outcome:

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

1. Analyze RLC circuits and coupled circuit to obtain the voltage -current relations
2. Verify DC netwok theorems by setting up various networks
3. Calibrate the single phase and three phase energy meter at various power faqctors
4. Measure power in a single and three phase circuits by various methods
5. Determine magnetic characteristics of iron ring specimen
6. Measure high and low resistances using various bridges
7. Use Electronic energy meter, TOD meter and clamp on meter

Text Book:

1. Sawhney AK: A course in Electrical and Electronic Measurements & instrumentation, Dhanpat Rai .
2. J B Gupta : A course in Electrical & Electronic Measurement & Instrumentation., S K Kataria & Sons
3. Kalsi H. S., Electronic Instrumentation, 3/e, Tata McGraw Hill, New Delhi, 2012

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE235	Electrical Technology lab	0-0-3-1	2016

Prerequisite : EE209 Electrical technology

Course Objectives

- To impart working knowledge on electrical circuits, A C machines, DC machines and transformers.

List of Exercises/Experiments : (Minimum 10 experiments are mandatory)

1. Verification of Thevenin's theorem
2. Verification of Norton's theorem
3. Verification of Superposition theorem
4. Verification of Maximum power transfer theorem
5. Power measurement in 3 phase balanced circuits
6. Power measurement in 3 phase unbalanced circuits
7. Load test on DC shunt motor
8. Load test on DC series motor
9. Speed control of DC shunt motor
10. Open circuit characteristics of DC series motor.
11. Open circuit characteristics of dc shunt motors
12. Swinburne's test and separation of losses in DC machine.
13. Load test on single phase transformer
14. Load test on 3-phase induction motor
15. No load test on 3- phase induction motors.

List of major equipment

DC shunt motor, DC series motor, DC series motor, single phase transformer, 3-phase induction motor, Watt meters, Ammeters, voltmeters, Tachometers.

Expected outcome.

- On completion of this lab course, the students will be able to understand the concept of electric circuits and the performance characteristics of electrical machines.

Text Book:

Theraja B.L., Theraja A.K. *A Text Book of Electrical Technology*, Vol.II "AC & DC Machines", publication division of Nirja construction & development (p) Ltd., New Delhi.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE236	ELECTRICAL TECHNOLOGY AND SAFETY LAB	0-0-3-1	2016

Prerequisite: EE212 Electrical technology and safety

Course Objectives

- To provide practical experience for verifying circuit theorems.
- To expose the students on the operation of Dc motors, Induction motors, transformer and give them experimental skill.

List of Experiments:

1. Verification of Kirchhoff's Laws
2. Verification of Superposition Theorem.
3. Measurement of power in an A.C circuit by 3 ammeter and 3 voltmeter method
4. Load test on d.c series motor
5. Speed characteristics of d.c shunt motor
6. Regulation of Transformer
7. Load characteristics of 3 phase induction motor
8. Study of protective relays and circuit breakers
9. Study of insulation testing and ground testing
10. Study of B.H curve on C.R.O
11. Study about cardio pulmonary resuscitation(CPR)

Expected outcome

- At the end of this course, the students will have exposed to the fundamentals of electric circuit theorem and the working of various electrical machines.

Text Books

- V.K Mehta,Rohit Mehta. "Principles of Electrical Machines".S Chand Publishers
- S.L. Uppal : A Textbook of Electrical Engineering, Khanna Publishers, Delhi
- H. Cotton : Electrical Technology, Wheeler Publishing Company

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 -power flow through lines-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-power Distribution system-need for protection-circuit breakers-protective relay types -Types of protection causes of over voltages -insulation coordination

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. B.R. Gupta: "Power system Analysis and Design", Wheeler publishers
2. J.B. Gupta, "A course in Electrical Power", Kataria and sons, 2004.
3. 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. Tuned power lines-power flow through lines-Basics only		
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. Underground Cables -types of cables -insulation resistance -voltage stress -grading of cables -capacitance of single core and 3 -core cables -current rating.	9	15%
IV	**HVDC Transmission:** Comparison between AC &DC Transmission ,Power flow equations and control, Types of DC links **Flexible AC Transmission systems**: Need and Benefits, SCV, Configuration of FC + TCR, Series compensation, Configuration of TCSC **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.	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, Balanced Beam, 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)	12	
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 **Causes of over voltages –** surges and traveling waves – voltage waves on loss less transmission lines, Bewley Lattice diagram. Protection against over voltages - Surge diverters - Insulation co-ordination	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
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
EE309	Microprocessor and Embedded Systems	3-0-0-3	2016

Prerequisite: Nil

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 and 8086; 8051 microcontroller- internal architecture, addressing modes, instruction types, Introduction to 8051 C programming.

Expected Outcome:

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

i. Apply the fundamentals of assembly level programming of 8085 and 8086 microprocessors.
ii. Work with standard microprocessor real time interfaces
iii. Develop skill for writing C programs for 8051 microcontroller
iv. Design microprocessors/microcontrollers-based systems.

Text books:

1. Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill, Education, New Delhi, Third Edition.
2. Mathur A., Introduction to Microprocessors, Tata McGraw Hill, New Delhi, 1992.
3. Mohamed Ali Mazidi,Janice Gillispie Mazidi," The 8051 microcontroller and embedded systems using Assembly and C", 2/e, Pearson education /PHI
4. Rafiquzzaman, Microprocessor Theory and Application, PHI Learning, First Edition.
5. Ramesh Gaonkar, Microprocessor, Architecture, Programming and Applications, Penram International Publishing; Sixth edition, 2014.
6. Ray Ajoy and Burchandi, Advanced Microprocessor & Peripherals, Tata McGraw Hill, Education, New Delhi, Second Edition.
7. Scott MacKenzie, Raphael C W Phan, " The 8051 Microcontroller", Fourth Edition, Pearson education

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Internal architecture of 8085 microprocessor –Instruction set - 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%

FIRST INTERNAL EXAMINATION			
III	IO and memory interfacing – Address decoding– interrupt structure of 8085. I/O ports- Programmable peripheral interface PPI 8255 - Modes of operation. Interfacing of LEDs, ADC and DAC with 8085	7	15%
IV	Internal Architecture of 8086 – Segment Registers - Instruction Pointer – Flag Register – Index Registers - Stack Pointer Register. Segmentation and Pipe lining, Minimum and maximum modes of operation of 8086. Addressing modes	7	15%
SECOND INTERNAL EXAMINATION			
V	Assembler and assembler directives –Instruction set of 8086, Assembly language programming, Simple programs- Addition of 8 bit binary and decimal numbers, Subtraction of 2 decimal numbers, Addition and subtraction of two 16 bit numbers, Multiplication and division of 8 bit numbers, Sorting of a series of 8 bit numbers, Code conversion-BCD to Binary, Binary to BCD.	7	20%
VI	Intel 8051 Microcontroller, Internal Architecture - I/O port structure, memory organisation, general purpose RAM, Bit addressable RAM, register banks, special function registers; Instruction set summary-addressing modes, instruction types, Introduction to 8051 C programming-pulse wave generation, buzzer interface**.**	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
EE312	Electrical and Electronics Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objective

- To give exposure to the working of Electrical Machines that function as prime movers in industrial systems/machine-tools.
- To make aware on factors affecting the choice of motor for a given application
- To introduce power electronics which form the essential part of modern drives

Syllabus

Transformers, Induction motors, Direct current machines, Control system motors, Factors affecting the choice of motor, Power Electronics

Expected Outcome

The students will be able to

i. know about electrical machines that form part of various industrial systems
ii. understand the working of electric machine driven industrial systems and machine tools in a better way.

Text Book:

Hughes, Edward, et al. "*Hughes electrical and electronic technology"*. Pearson education, 2008.

References:

1. Gross, Charles A. "*Electric machines"*. CRC press, 2006.
2. Vithayathil, Joseph. "*Power electronics principles and applications"*. Tata McGraw-Hill Education, 1995.
3. Venkataratnam, K. "*Special electrical machines"*. Universities Press, 2009.
4. Mohan, Ned, and Tore M. Undeland. "*Power electronics: converters, applications, and design"*. John Wiley & Sons, 2007.
5. Guru, Bhag S., and Hüseyin R. Hiziroglu. "*Electric machinery and transformers"*, Oxford University Press, 2001.

Course Plan

Module	Contents	Hours	End Sem. exam marks
I	Transformers-Operating principle, ideal and practical transformers, EMF equation, No load phasor diagram, equivalent circuit, phasor diagram of a transformer on load. Approximate equivalent circuit of transformer and its simplification. Voltage regulation, efficiency, condition for maximum efficiency, transformer tests.	9	15%
II	Three phase Induction motors- principle of action, frequency of rotor emf and current. Factors determining the torque. Torque-slip curve, comparison of slip ring and cage rotors. Single phase induction motors-capacitor run induction motor, split phase motors, shaded pole motors.	6	15%
First Internal Exam			

III	Direct current machines-general arrangement of a dc machine, calculation of e.m.f. generated in an armature winding, armature reaction, commutation. Armature and field connections. A dc machine as generator or motor. Speed of a motor, speed characteristics of shunt, series and compound motors. Torque characteristics of shunt, series and compound motors.	8	15%
IV	Control system motors-Motors for regulators, RPC system requirements, Geneva cam, stepper motor, variable reluctance motor, hybrid stepping motor, drive circuits.	6	15%
Second Internal Exam			
V	Motor selection-Factors affecting the selection motors-speed, power rating and duty cycles, load torques. The motor and its environment.	4	20%
VI	Power electronics- introduction to power electronics, thyristor circuits, limitations to thyristor operation, thyristors in practice, The fully controlled a.c./d.c. converter, ac/dc inversion. Switching devices in inverters.	9	20%
End Semester Exam			

Question Paper Pattern

Maximum marks: 100 Time: 3 hours

The question paper shall consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, 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
EE336	Electrical and Electronics Engineering Lab	0-0-3-1	2016

Prerequisite : EE312 Electrical and electronics engineering

Course Objective

- To provide necessary practical knowledge related to the theory of electrical machines such as transformers, induction machines and dc machines.
- To study the characteristics of normal diodes and Zener diodes
- To familiarize with various instruments like CRO, multi-meters etc. used to measure electrical quantities..
- To do a simple project which can be performed in groups is given.

List of Experiments

1. Single phase transformer – load test
2. Single phase transformer-OC and SC test- determination of approximate equivalent circuits-pre-determination of efficiency and regulation.
3. Starting of three phase induction motor using different kinds of starters (squirrel cage and slip ring)-observation of currents and voltages.
4. Load test on three phase squirrel cage /slip ring induction motors.
5. DC shunt generator magnetization characteristics plot (determination of critical field resistance and critical speed).
6. DC shunt generator load test.
7. DC compound generator load test (cumulative and differential).
8. Observation of diode characteristics on CRO.
9. Zener diode characteristics.
10. **Project :** The students can do a project related to designing a timer using IC 555 to understand the application of such timer ICs. The timer should be able to keep a light on for a given period. They can do the project in groups. Any other interesting project using IC 555 can also be tried.

Expected outcome:

The students will be able to

i. Understand the principles of electrical machines
ii. Do characteristic tests on transformers, induction motors and DC generators
iii. Visualise diode characteristics on CRO
iv. Execute simple projects using IC 555

Course code	Course name	L-T-P-Credits	Year of Introduction
EE337	ELECTRICAL ENGINEERING LAB	0-0-3-1	2016

Prerequisite : EE216 Electrical Engineering

Course objectives

- To study the performance characteristics of dc and ac machines and transformers.
- To familiarize various electrical measurement methods

Experiments

1. Plot open circuit characteristics of DC shunt generator for rated speed - Predetermine O.C.C. for other speeds - Determine critical field resistance for different speeds
2. Load test on DC shunt generator - Plot external characteristics - Deduce internal Characteristics
3. Load test on DC series motor - Plot the performance characteristics
4. OC and SC tests on single phase transformer - Determine equivalent circuit parameters - Predetermine efficiency and regulation at various loads and different power factors - verify for unity power factor with a load test
5. Load test on 3 phase cage induction motor - Plot performance curves
6. Resistance measurement using (a) Wheatstone's bridge (b) Kelvin's double bridge
7. Measurement of self-inductance, mutual inductance and coupling coefficient of (a) Transformer windings (b) air cored coil
8. Power measurement in 3 phase circuit - Two wattmeter method
9. Extension of ranges of ammeter and voltmeter using shunt and series resistances
10. Calibration of Single phase energy meter by direct loading

Expected outcomes

- At the end of the semester students are expected to be familiar with the working and characteristics of DC and AC machines.etc

Course code	Course Name:	L-T-P-Credits	Year of Introduction
EE339	ELECTRICAL ENGINEERING LAB	0-0-3-1	2016

Prerequisite : EE214 Electrical technology and instrumentation

Course Objectives:

- Introduction to devices commonly used in carrying out experiments pertaining to the domain of electrical engineering.
- Familiarization in setting up of experiments in a laboratory environment.
- To carryout load test on various electrical machinery and evaluate their performance.
- Provide an environment to correlate theoretical knowledge gained in the class room with the physical world.

List of Exercises/ Experiments (Minimum 12 experiments/exercises are mandatory)

1. Study of 3-point and 4-point starters for D.C machines
   Equipment: 3 Point Starter, 4 Point Starter.

2. OCC of self excited D.C machines – critical resistances of various speeds. Voltage built-up with a given field circuit resistance. Critical speed for a given field circuit resistance.
   Equipment: D.C Motor-Generator set, Ammeter, Voltmeter, Rheostat.

3. OCC of separately excited D.C machines.
   Equipment: D.C Motor-Generator Set, Ammeter, Voltmeter, Rheostat.

4. Load test on shunt generator – deduce external, internal and armature characteristics.
   Equipment: D.C Shunt Generator- Motor Set, Ammeter, Voltmeter, Rheostat, Loading Rheostat.

5. Load test on compound generator.
   Equipment: Compound Generator, Ammeter, Voltmeter, Rheostat, Loading Rheostat.

6. Swinburne's test on D.C machines.
   Equipment: D.C Shunt Motor, Ammeter, Voltmeter, Rheostat.

7. Brake test on D.C shunt motors and determination of characteristics.
   Equipment: D.C Shunt Motor, Ammeter, Voltmeter, Rheostat.

8. Brake test on D.C series motors and determination of characteristics.
   Equipment: D.C Series Motor, Ammeter, Voltmeter.

9. Brake test on D.C compound motors and determination of characteristics.
   Equipment: D.C Compound Motor, Ammeter, Voltmeter, Rheostat.

10. O.C and S.C tests on single phase transformers – calculation of performance using

equivalent circuit – efficiency, regulation at unity, lagging and leading power factors.
Equipment: Single Phase Transformer, Ammeter, Voltmeter, Wattmeter, Autotransformer.

11. Load test on single phase transformers.
Equipment: Single Phase Transformer Ammeter, Voltmeter, Wattmeter, Loading Rheostat

12. Alternator regulation by emf and mmf methods.
Equipment: Alternator Set, Ammeter, Voltmeter, Rheostat.

13. Study of starters for three phase induction motors.
Equipment: Star Delta Starter, TPDT switch, Autotransformer.

14. Load tests on three phase squirrel cage induction motors.
Equipment: 3 Phase Squirrel Cage Induction Motor, Ammeter, Voltmeter, Wattmeter.

15. Load tests on three phase slip ring induction motors.
Equipment: 3 Phase Slip Ring Induction Motor, Ammeter, Voltmeter, Wattmeter.

16. Load tests on single phase induction motors.
Equipment: Single Phase Induction Motor, Ammeter, Voltmeter, Wattmeter.

17. Polarity, transformation ratio of single phase transformer.
Equipment: Single Phase Transformer, Ammeter, Voltmeter.

18. Equivalent circuit of three phase squirrel cage induction motor.
Equipment: 3 Phase Squirrel Cage Induction Motor, Ammeter, Voltmeter, Wattmeter.

Course Outcome:

Upon successful completion of the course, the student will be:

i. Familiar with the arrangement and conduct of experiments in an electrical laboratory environment.
ii. Able to note down relevant readings and perform calculations while an electrical experiment is in progress.
iii. Able to comprehend the factors responsible for variation between theoretical and experimental results.

Text Book:

- J. B. Gupta; Theory and Performance of Electrical Machines; S.K. Kataria & Sons.

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 Design	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. Exam Marks
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 Engineering	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To provide 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 Matthews Introduction 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 Sources of Energy	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.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE401	Electronic Communication	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To introduce the applications of communication technology.
- To understand the methods and techniques used in communication field.

Syllabus:

AM and FM fundamentals-AM and FM transmitters and receivers-Television and radar systems-Digital communication-Satellite communication-Cellular telephone.

Expected outcome

The students will

i. Understand the need of modulation in transferring a signal through either wireless or wired communication systems
ii. Be able to apply analog modulation techniques and receiver fundamentals in analog communication.
iii. Be to apply baseband digital encoding & decoding techniques in the storage / transmission of digital signal through wired channel
iv. Understand the performance of communication systems in the presence of noise and interference

Text Books:

1. Kennedy G., *Electronic Communication Systems*, McGraw-Hill, New York, 2008.
2. Roody and Coolen, *Electronic Communication*, Prentice Hall of India LTD., New Delhi, 2007.

References:

1. William Scheweber, *Electronic Communication Systems*, Prentice Hall of India LTD, New Delhi, 2004.
2. Wayne Tomasi, *Electronic Communication Systems*, Prentice Hall of India LTD, New Delhi, 2004.
3. Frank R. Dungan, *Electronic Communication Systems*, 3/e, Vikas Publishing House, 2002.
4. Simon Haykins, *Communication Systems*, John Wiley, USA, 2006.
5. Bruce Carlson. *Communication Systems*, Tata McGraw Hill, New Delhi, 2001.
6. Taub and Schilling, *Principles of Communication Systems*, McGraw-Hill, New York, 2008.
7. Anokh Singh, *Principles of Communication Engineering*, S. Chand and Company Ltd., Delhi.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**AM and FM fundamentals** AM – Frequency spectrum – vector representation – power relations – generation of AM – DSB, DSB/SC, SSB, VSB FM – frequency spectrum – power relations	6	15%
II	**AM and FM transmitters and receivers** Block diagrams of low power and high power AM transmission - AM receivers: straight receivers super hetrodyne receiver - choice of intermediate frequency - simple AVC circuit Block diagrams of direct FM transmitter and Armstrong transmitter - FM receivers (balanced - slope detector and Foster-Seely discriminator only).	8	15%
FIRST INTERNAL EXAMINATION			

III	**Television and radar systems** Principles of television engineering - Requirements and standards – need for scanning - types of camera tubes and picture tubes - B/W and colour systems - PAL - CCTV - Cable TV-high definition television. Radar and navigation: principle of radar and radar equation, block schematics of pulsed radar.	8	15%
IV	**Digital communication:** Principles of digital communication – - Sampling process-pulse modulation Techniques- sampling process-PAM, PWM and PPM concepts - PCM encoder and decoder Applications of data communication	6	15%
SECOND INTERNAL EXAMINATION			
V	**Satellite communication** Multiple access (MA) techniques-FDMA, TDMA, CDMA, SDMA - applications in satellite communication wire, MA techniques applications in wired communication. in satellite communication, earth station; Fibers – types: sources, detectors used, digital filters, optical link	8	20%
VI	**Cellular telephone -** Basic concepts, frequency reuse, interference cell splitting, sectoring, cell system layout, cell processing. Fibers – types: sources, detectors used, digital filters, optical link: Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication	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.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE402	Special Electrical Machines	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To get an overview of some of the special machines for control and industrial applications

Syllabus

AC Servomotors – construction – operation - DC servomotors – Stepper motor – operation – types-modes of excitation – AC series motor – Universal motor – Hysteresis motor – Reluctance motor – Switched reluctance motor – Permanent magnet DC motor – Brushless DC motor – Linear motors – Linear induction motors.

Expected outcome.

- The students will gain knowledge in the construction and principle of operation of certain special electrical machines having various applications.

Text Book:

E. G. Janardhanan, '*Special Electrical Machines*' PHI Learning Private Limited.

References:

1. Irving L. Kosow.'*Electrical Machinery and Transformers*', Oxford Science Publications.
2. T. J. E. Miller, '*Brushless PM and Reluctance Motor Drives*'.C.Larendon Press, Oxford.
3. Theodore Wildi, '*Electric Machines, Drives and Power Systems*', Prentice Hall India Ltd.
4. Veinott & Martin,'*Fractional & Subfractional hp Electric Motors*'.McGraw Hill International Edn.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	AC Servomotors- Construction-principle of operation – performance characteristics – damped AC servomotors – Drag cup servomotor – applications. DC servomotors – field and armature controlled DC servomotors – permanent magnet armature controlled – series split field DC servomotor.	7	15%
II	Stepper motors – Basic principle – different types – variable reluctance- permanent magnet – hybrid type – comparison – theory of operation – monofilar and bifilar windings – modes of excitation – drive circuits – static and dynamic characteristics – applications	7	15%
	FIRST INTERNAL EXAMINATION		
III	Single phase special electrical machines – AC series motor-construction – principle of working – phasor diagram – universal motor Hysteresis motor- constructional details- principle of operation – torque-slip characteristics – applications.	7	15%
IV	Reluctance motors – principle of operation – torque equation – torque slip characteristics-applications. Switched reluctance motors – principle of operation – power converter circuits – torque equation – different types – comparison – applications.	7	15%

SECOND INTERNAL EXAMINATION			
V	Permanent Magnet DC Motors – construction – principle of working. Brushless dc motor – construction – trapezoidal type-sinusoidal type – comparison – applications.	7	20%
VI	Linear motors – different types – linear reluctance motor – linear synchronous motors – construction – comparison. Linear induction motors – Expression for linear force – equivalent circuit – 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 CODE	COURSE NAME	L-T-P-CREDITS	YEAR OF INTRODUCTION
EE403	DISTRIBUTED GENERATION AND SMART GRIDS	3-0-0-3	2016

Prerequisite: Nil

Course objective.

- To develop a conceptual introduction to various distributed generation systems, micro grids, smart grids and their control

Syllabus:

Introduction to distributed generation and smart grids - Distributed Energy Resources – Micro Grids and their control – Protection issues for Microgrids - Smart Grids: Components – NIST Reference architecture – Smart meters - Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU) - demand response- Demand Side Management - Smart Substations, HAN, NAN, SANET, Cloud computing in smart grid – Power Quality issues with smart grid

Expected Outcome:

The students will be able to:

i. Explain various distributed generation systems
ii. Understand the microgrids and their control schemes
iii. Understand various developments happening in the field of Smart Grids.

TEXT BOOKS/REFERENCES:

1. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, ISBN: 978-0-470-62761-7, Wiley
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, ISBN: 978-0-470-88939-8, Wiley
3. R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, “Electrical Power System Quality”, McGraw-Hill
4. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, ISBN: 978-0-470-05751-3, Wiley
5. S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, ISBN 978-1-84919-014-5, IET, 2009

COURSE PLAN

Module	Contents	Hours	End. Sem. Exam. Marks
I	Distributed generation – Introduction - Integration of distributed generation to Grid – Concepts of Micro Grid - Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economical advantages of Microgrid -	7	15%

	Challenges and disadvantages of Microgrid development Smart Grid: Evolution of Electric Grid - Definitions and Need for Smart Grid, Opportunities, challenges and benefits of Smart Grids		
II	Distributed energy resources: Introduction - Combined heat and power (CHP) systems - Solar photovoltaic (PV) systems – Wind energy conversion systems (WECS) - Small-scale hydroelectric power generation - Storage devices: Batteries: Lead acid, nickel metal hydrate, and lithium ion batteries , ultra-capacitors, flywheels Control of Microgrids: Introduction to Central Controller (CC) and Microsource Controllers (MCs) - Control functions for microsource controller, Active and reactive power control, Voltage control, Storage requirement for fast load tracking, Load sharing through power-frequency control	6	15%
III	Protection issues for Microgrids: Introduction, Islanding, Different islanding scenarios, Major protection issues of stand-alone Microgrid - Impact of DG integration on electricity market, environment, distribution system, communication standards and protocols. Smart Grid: Components – NIST Smart Grid Reference Architecture Introduction to Smart Meters, Electricity tariff – one part tariff, two tariff and maximum demand tariff - Dynamic pricing: time-of-use (TOU) pricing, critical-peak pricing (CPP) and Real Time Pricing- Automatic Meter Reading(AMR), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation. Intelligent Electronic Devices (IED) and their application for monitoring & protection, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU).	7	15%
IV	Smart energy efficient end use devices-Smart distributed energy resources- Load Curves-Load Shaping Objectives-Methodologies - Peak load shaving - Energy management-Role of technology in demand response- Demand Side Management – Numerical Problems	7	15%
V	Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood-Area Networks (NANs), Sensor and Actuator Networks (SANETs) Smart Substations, Substation Automation, IEC 61850 Substation Architecture, Feeder Automation.	7	20%

VI	Cloud computing in smart grid: Private, public and Hybrid cloud. Cloud architecture of smart grid. Power quality: Introduction - Types of power quality disturbances - Voltage sag (or dip), transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker - Harmonic sources: SMPS, Three phase power converters, arcing devices, saturable devices, fluorescent lamps, harmonic indices (THD, TIF, DIN, C – message weights) Power quality aspects with smart grids.	8	20%

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
EE404	INDUSTRIAL INSTRUMENTATION AND AUTOMATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart knowledge about Industrial instrumentation and automation

Syllabus:

Dynamic characteristic of instrumentation- Transducers: Characteristics, Applications – Nano instrumentation - signal conditioning, MEMS, Virtual instrumentation-Automation system - actuators – sequence control, PLC

Expected Outcome:

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

i. Select instruments and transducers for various physical variables.
ii. Get an insight on data acquisition, processing and monitoring system
iii. Design various signal conditioning systems for transducers.
iv. Analyze dynamic responses of various systems.
v. Get the concepts of virtual instrumentation
vi. Understand the programming realization of PLC

Text books:

1. Curtis D Johnson ," *Process Control Instrumentation Technology"*, PHI, 1986
2. Doeblin E.O, 'Measurement Systems: Application and Design, Fourth Edition, McGraw Hill, Newyork, 1992
3. DVS. Murty, 'Transducers and Instrumentation' Second Edition, PHI Learning Pvt Ltd New Delhi ,2013
4. Madhuchhanda Mitra, Samarjit Sengupta, 'Programmable Logic Controllers and Industrial Automation An Introduction', Penram International Publishing (India) Pvt Ltd., 2009
5. Mickell. P. Groover 'Automation, Production and computer integrated manufacturing' Prentice Hall of India, 1992
6. Patranabis, D., 'Principles of Industrial Instrumentation', Second Edition Tata McGraw Hill Publishing Co. Ltd.. New Delhi
7. Robert B. Northrop, 'Introduction to instrumentation and measurements', CRC, Taylor and Francis 2005

References:

1. G.K.McMillan, 'Process/Industrial Instrument and control and hand book' McGraw Hill, New York,1999
2. Michael P .Lucas, 'Distributed Control system', Van Nastrant Reinhold Company, New York

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Process Control - block diagram of process control loop, definition of elements. Sensor time response - first and second order responses. Review of Transducers: Characteristics and Choice of transducer-	6	15%

	factors influencing choice of transducer		
II	Applications of Transducers Displace measurement: Resistance potentiometer, Capacitive and Inductive. Capacitive differential pressure measurement Torsional, shearing stress and rotating shaft Torque measurement using strain gauge. Flow measurement :Hotwire anemometer, constant resistance Constant current type Eddy current sensors, Variable reluctance tachometers Phase measurement :Analog and digital phase detectors Nano Instrumentation	8	15%
FIRST INTERNAL EXAMINATION			
III	Signal conditioning circuits-Instrumentation amplifiers- Unbalanced bridge. Bridge linearization using op amp Precision rectifiers, Log amplifiers, Charge amplifiers, Isolation amplifier, Switched capacitor circuits, Phase sensitive detectors, Noise problem in instrumentation and its minimisation	7	15%
IV	Micro Electromechanical system (MEMS) Advantages and Applications, MEMS micro sensors and actuators, Manufacturing process: Bulk micro machining and surface micromachining, MEMS accelerometers Virtual instrumentation system: architecture of virtual instruments – Virtual instruments and traditional instruments – concepts of graphical programming	7	15%
SECOND INTERNAL EXAMINATION			
V	Overview of Automation System - Architecture of Industrial Automation Systems, Different devices used in Automation Actuators, definition, types, selection. Pneumatic, Hydraulic, Electrical, Electro-Pneumatic and valves , shape memory alloys	7	20%
VI	Introduction to Sequence Control, PLCs - Working, Specifications of PLC Onboard/Inline/Remote IO's, Comparison of PLC & PC, Relay Ladder Logic- PLC Programming- realization of AND, OR logic, concept of latching, Introduction to Timer/Counters, Exercises based on Timers, Counters. Basic concepts of SCADA, DCS and CNC	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
EE405	Electrical System Design	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

- To gain the knowledge of acts and rules used for regulating the electrical supply in our country.
- To impart sound knowledge in the design and estimation of low voltage and medium voltage electrical installations.
- To gain the knowledge of selection of distribution transformers and their installations.
- To gain the knowledge of Earthing designs in different installations and the standard dimensions of earthing systems.

Syllabus

Electrical system design practices – general awareness of IS Codes, Electricity Acts & Rules, NEC etc. Domestic Installations, Motor Installations, 11 kV substation installations. Cinema theatre, auditorium and high rise building installations. Standby generator selection and their Installations. Underground cable installations and their accessories. Types of earthing, lightning arresters, fire fitting and lifts.

Expected outcome

The students will

i. Know the basic Rules and regulations in electrical installations.
ii. To prepare the schematic diagram, installation plan, quantity of materials and estimate for different electrical installations.

Text Book:

1. J. B. Gupta, A Course in Electrical Installation Estimating and Costing, S.K. Kataria & Sons; Reprint 2013 edition (2013).
2. K. B. Raina, S. K. Bhattacharya, Electrical Design Estimating Costing, NEW AGE; Reprint edition (2010).
3. M.K.Giridharan, Electrical Systems Design, , M/s I K International Publishers, New Delhi, 2nd edition, 2016

Data Book (Approved for use in the examination):

M K Giridharan, Electrical Systems Design Data Hand book, , M/s I K International Publishers , New Delhi, 2011

References:

1. National Electric Code, Bureau of Indian Standards publications, 1986.
2. Relevant Indian Standard – specifications (IS – 732, IS – 746, IS – 3043, IS – 900), etc.
3. S.L.Uppal, Electrical Wiring Estimating & Costing, Khanna Publishers (2008)

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General awareness of IS Codes (IS 3043, IS 732, IS 2675, IS 5216-P1-2, IS 2309), The Indian Electricity Act 1910, The Indian Electricity supply Act 1948, Indian Electricity Rules 1956, The Electricity Regulatory Commission Act 1998, Electricity Act 2003, Bureau of Energy Efficiency (BEE) and its labeling. National Electric Code (NEC) - scope and safety aspects applicable to low and medium (domestic) voltage installations, Electric services in buildings, Classification of voltages, standards and specifications.	8	15%
II	Safety aspects applicable to low and medium voltage installations. General aspects of the design of electrical installations for domestic dwellings (low and medium voltage installations)–connected load calculation, sub circuit determination, selection of main distribution board, sub distribution board, MCB, ELCB, MCCB and cables for sub	10	15%

	circuits. Pre-commissioning tests of domestic installations.		
FIRST INTERNAL EXAMINATION			
III	Medium and HV installations – selection of cables and cable glands, guidelines for cable installation in detail. Panel boards: LT & HT control panel boards. Installation of induction motors: Design of distribution systems with light power and motor loads. Design of automatic power factor correction (APFC) Panel. Selection and installation of transformers, switchgears and protective devices – Design of indoor and outdoor 11 kV substation upto 630 kVA.	10	15%
IV	Air-conditioning loads and its specifications. Energy conservation techniques. Selection of standby generator – installation and its protection. Introduction to Automatic Main Failure (AMF) System. Pre-commissioning tests of cables, transformers and generators.	8	15%
SECOND INTERNAL EXAMINATION			
V	Design of earthing system for an HT consumer, Dimensions and drawings of typical earth electrodes (1) Pipe Earthing, (2) Plate Earthing. Touch, Step and Transfer potentials at EHT Sub-Stations, Earth-mat, installations of special equipment like X-Ray, Neon-Sign, Basics of lightning arresters.	8	20%
VI	Design of illumination systems – Yard lighting, street lighting and flood lighting. Kerala Cinema Regulation Act – 1958, design and layout of installation for recreational or assembly buildings, cinema theatre and high rise building. Design of Electrical system related to firefighting, lifts and escalators.	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 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
EE407	DIGITAL SIGNAL PROCESSING	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To impart knowledge about digital signal processing and its applications in engineering

Syllabus

Introduction to signals and systems – Discrete Fourier Transforms – Fast Fourier Transforms - Introduction to FIR and IIR systems - FIR filter design - Finite word length effects in digital Filters - Introduction to FDA Toolbox in MATLAB - Introduction to TMS320 Family - Design & Implementation and Filter Structures - Introduction to Code Composer Studio

Expected outcome .

The students will be able to:

i. Analyse DT systems with DFT
ii. Design digital filters IIR and FIR filters
iii. Analyse finite word length effects in signal processing
iv. Design filters using Matlab FDA tool box
v. Understand Digital Signal Controllers and their Applications

Text Books:

1. Alan V.Oppenheim, Ronald W. Schafer & Hohn. R.Back, "Discrete Time Signal Processing", Pearson Education, 2nd edition, 2005.
2. Emmanuel.C..Ifeachor, & Barrie.W.Jervis, "Digital Signal Processing", Second editi on, Pearson Education / Prentice Hall, 2002.
3. John G. Proakis & Dimitris G.Manolakis, "Digital Signal Processing Principles, Algorithms &Applications", Fourth edition, Pearson education / Prentice Hall, 2007

References:

1. Johny R. Johnson, Introduction to Digital Signal Processing, PHI, 2006.
2. P.P.Vaidyanathan, Multirate Systems & Filter Banks, Prentice Hall, Englewood cliffs, NJ, 1993.
3. S.K. Mitra, Digital Signal Processing, A Computer Based approach, Tata Mc GrawHill, 1998.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to signals and systems - Discrete Fourier transform: Frequency domain sampling, Discrete Fourier transform (DFT): DFT pair, properties of DFT, frequency response analysis of signals using the DFT, circular convolution using DFT , linear filtering based on DFT Fast Fourier transform (FFT); Introduction, Radix -2 decimation in time FFT algorithm, Radix-2 decimation in frequency algorithm.	7	15%
II	Introduction to FIR and IIR systems : Structures for realization of discrete time systems – structures for FIR and IIR systems – signal flow graphs, direct-form, cascade-form, parallel form, lattice and transposed structures and linear Phase FIR filters.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Design of digital filters – general considerations – causality and its	7	15%

	implications, characteristics of practical frequency selective filters IIR filter design : Discrete time IIR filter (Butterworth and Chebyshev) from analog filter – IIR filter (LPF, HPF, BPF, BRF) design by Impulse Invariance, Bilinear transfor mation, Approximation of derivatives. filter design		
IV	FIR filter design : Structures of FIR filter- Linear phase FIR filter – Filter design using windowing techniques, frequency sampling techniques	7	15%
SECOND INTERNAL EXAMINATION			
V	Finite word length effects in digital Filters : Fixed point and floating point number representations - Comparison - Truncation and Rounding errors - Quantization noise - derivation for quantization noise power - coefficient quantization error - Product quantization error - Overflow error – Round-off noise power - limit cycle oscillations due to product round-off and overflow errors - signal scaling **Introduction to FDA Toolbox in MATLAB:** Design of filters using FDA toolbox (**Demo/Assignment only**)	7	20%
VI	Introduction to TMS320 Family: Architecture, Implementation, C24x CPU Internal Bus Structure, Memory Central Processing unit , Memory and I/O Spaces , Overview of Memory and I/O Spaces, Program control Address Modes System Configuration and Interrupts clocks and low Power Modes Digital input / output (I/O), Assembly language Instruction , Instruction Set summary , Instruction Description, Accumulator, arithmetic and logic Instruction , Auxiliary Register and data page Pointer Instructions , TREG, PREG, and Multiply Instruction ,Branch Instructions , Control Instructions I/O and Memory Instruction **Design & Implementation and Filter Structures:** MATLAB functions and TMS320 Implementation (**Demo/Assignment only**) **Introduction to Code Composer Studio** (**Demo 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
EE409	Electrical Machine Design	3-0-0-3	2016

Prerequisite: EE202 & EE205

Course Objectives

- To impart knowledge on principles of design of static and rotating electrical machines.
- To give a basic idea about computer aided design (CAD) and finite element method.

Syllabus

Machine design basic principles, Heating and cooling of electrical machines, Magnetic circuit design, Design of - Dc machine, Synchronous machine , Three phase induction motor, Computer aided design, Finite element method.

Expected outcome

- The students will be able to design transformers, DC machines, synchronous machines and induction motors

Text Book:

1. A K Sawhney, " A Course in Electrical Machine Design", Dhanpat rai *and* sons, Delhi.

References:

1. M. V. Deshpande, " Design and Testing of Electrical Machines", Wheeler Publishing.
2. R. K. Agarwal, " Principles of Electrical Machine Design", Essakay Publications, Delhi.
3. Ramamoorthy M, "Computer Aided Design of Electrical Equipment", East-West Press.
4. M. N. O. Sadiku, " Numerical techniques in Electromagnetics", CRC Press Edition-2001.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Principles of electrical machine design - General design considerations - specifications of machines - types of enclosures - types of ventilation - heating - short time rating - overload capacity - temperature rise time curve - hot spot rating. Magnetic circuit calculation - calculation of field ampere turns - air gap mmf - effect of slot and ventilating duct - active iron length - mmf for teeth - real and apparent flux densities - mmf per pole Magnetic Leakage Calculation- Effects of Leakage. Armature Leakage –Components. Unbalanced Magnetic Pull-Practical aspects of unbalanced magnetic pull	8	15%
II	Design of transformers - single phase and three phase transformers - distribution and power transformers - output equation - core design - window area - window space factor - overall dimensions of core. Windings – no. of turns - current density - conductor section - Cooling of transformers	6	15%
FIRST INTERNAL EXAMINATION			
III	Design of DC machines - output equation - specific loading - choice of speed and no of poles - calculation of main dimensions - choice of type of winding - number of slots - number of conductors per slot-current density - conductor section - slot insulation -	8	15%

	length of air gap - design of field winding - conductor cross section - height of pole - design of inter pole - flux density under inter pole - calculation of turns of inter polar winding – design of compensating winding – brushes and commutators.		
IV	Design of synchronous machines - specific loading - output equation - main dimensions - types of winding - number of turns - number of slots and slot design - field design for water wheel and turbo alternators - cooling of alternators.	6	15%
SECOND INTERNAL EXAMINATION			
V	Design of three phase induction motors - main dimensions - stator design - squirrel cage and slip ring types - number of stator and rotor slots - rotor bar current - design of rotor bar - end ring current - design of end ring - design of slip ring rotor winding.	7	20%
VI	Introduction to computer aided design. Analysis and synthesis methods -hybrid techniques. Introduction to Finite element method - historical background, applications, advantages. Study of new computer aided machine software using Finite Element Case study: Complete design of an ac machine –steps.(Assignment 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
EE431	Power Systems Lab	0-0-3-1	2016

Prerequisite : EE306 Power System Analysis

Course Objectives

- Impart practical knowledge about various power system equipment
- Get a knowledge about the operation of power systems and the philosophy behind the relay settings, fault calculations etc.
- Simulate the power system operations which will be helpful in the design of power systems

List of Exercises/Experiments: (At least 12 experiments out of 18 experiments listed are mandatory**)**

1. **Visit a local Substation.**
   Aim: To see firsthand apparatus that will be studied in this course and learn about their role in operation and protection of power systems.
2. **Introduction to PSCAD/MATLAB/MIPOWER**
   Aim: 1). Learn the usage of PSCAD/MATLAB/MIPOWER in modeling of ac circuits and plotting of results.
   2). Understanding reactive power and power factor in single-phase and three-phase circuits.
3. **Transmission Line and Modeling.**
   Aim: Obtaining the parameters of a 345 kV transmission line and modeling it in PSCAD/MATLAB/MIPOWER
4. **Power Flow**
   Aim: To carry out power flow calculations.
5. **Transformers in Power Flow.**
   Aim: To look at the influence of including a tap-changer and a phase-shifter on power flow and bus voltages.
6. **Including an HVDC Transmission Line for Power Flow.**
   Aim: 1). To include an HVDC transmission line and see its effect on power transfer on other transmission line.
   2). To understand the operating principle of 12-pulse thyristor converters used in HVDC transmission systems.
7. **Power Quality.**
   Aim: To obtain the current harmonics drawn by power electronics interface.
8. **Synchronous Generators.**
   Aim: To obtain the effect of sudden short-circuit on a synchronous generator output.
9. **Voltage Regulation.**
   Aim: 1). To study the effect of real and reactive powers on bus voltages.
   2). Understanding the operation of a Thyristor Controlled Reactor (TCR).
10. **Transient Stability.**
    Aim: To simulate transient stability in a 3-bus example power system.

10. **A. Making a Power System Reliable.**
    Aim: 1). To understand the planning/design process that goes into making a power system reliable.

11. AGC and Economic Dispatch.

Aim: Study the dynamic interaction between two control areas using *Simulink* modeling and economic dispatch.

12. Short Circuit Faults and Overloading of Transmission Lines.

Aim: To study the effect of short-circuit faults and overloading of transmission lines.

12.A. Fault Analysis with Relay Settings.

Aim : To study a power system with faults and determine relay settings based on calculated fault currents

13. Switching Over-Voltages and Modeling of Surge Arresters.

Aim. : To study over-voltages resulting from switching of transmission lines and limiting them by sing ZnO arresters

14. Power Factor improvement:

Aim : To calculate rating of capacitors for power factor correction for a load and verifying it experimentally.

15. Solar Power Calculations :

Aim : To calculate the rating of solar panel required for a given area on rooftop or for a given load

16. Demonstration of Ferranti Effect on a transmission line

17. Methods of Insulation Testing

18. Modern Energy Meter calibration schemes

Expected outcome.

- Students will be able to design, setup and analyse various power systems and its simulations.

Text Book:

Ned Mohan, First Course in Power Systems , Wiley.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE461	Modern Operating Systems	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To impart the knowledge on the need and requirement of an interface between Man and Machine.
- To teach the features of operating systems and the fundamental theory associated with process, memory and file management components of operating systems.

Syllabus :

Operating System Structure, Operating system services, Process management, Memory management, File management, Storage structure, security issues.

Expected outcome.

The students will be able to

i. describe the general architecture of computers
ii. describe, contrast and compare differing structures for operating systems
iii. understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files

Text Book:

William Stallings, Operating Systems: Internals and Design Principles, 6 th Ed., Pearson Education

References:

1. Nutt G.J., Operating Systems, 3 rd Ed., Pearson Education.
2. Silberschatz, Galvin, & Gagne, Operating System Concepts, 8 th Ed., Wiley
3. Tanenbaum A.S., Modern Operating Systems, 3 rd Ed., Prentice Hall

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction-Definition– Operating System Structure- Operating System Operations, Process Management- Memory Management- Storage Management- Protection and Security- Distributed Systems-	7	15%
II	Computing Environments- Open Source Operating Systems- Operating-System Services- User Operating-System Interface- System Calls- Types of System Calls- System Programs	7	15%
	FIRST INTERNAL EXAMINATION		
III	Process Management- Process Concept- Operations on Processes- Threads Overview- Multithreading Models- Thread Libraries- Threading Issues - CPU Scheduling- Basic Concepts- Scheduling Criteria- Scheduling Algorithms- Thread Scheduling- Multiple-Processor Scheduling- Process Synchronisation-	6	15%
IV	Memory Management-Swapping- Contiguous Memory Allocation- Paging Segmentation- Virtual Memory- Demand Paging	6	15%

SECOND INTERNAL EXAMINATION			
V	- File Management- File-System Interface- File Concept- Access Methods - Directory and Disk Structure - File-System Mounting - File Sharing- Protection- File-System Implementation- File-System Structure- File-System Implementation- Directory Implementation- Allocation Methods Free-Space Management - Efficiency and Performance	8	20%
VI	Mass Storage Structure- Disk Scheduling- Disk Management- RAID Structure - Stable Storage Implementation- Protection and Security- Protection- Goals of Protection- Principles of Protection- Domain of Protection- Access Matrix Implementation of Access Matrix- Access Control- Revocation of Access Rights Security- The Security Problem -Program Threats- System and Network Threats	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 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
EE462	Design of Digital Control Systems	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To introduce the need and concept of digital control system.
- To impart knowledge about different strategies adopted in the design of digital controllers.
- To familiarize with the design of different types of digital controllers.

Syllabus

Basic digital control system-Pulse transfer function-Digital PID controller design- compensator design using frequency response - compensator design using root locus - Direct design-method of Ragazzini - Dead-beat controller design - State space analysis and controller design.

Expected outcome.

On successful completion, the students will have the ability to

i. design digital controllers.
ii. analyse discrete time system using state space methods.
iii. analyse the stability of discrete time system.

Text Books:

1. Benjamin C. Kuo, Digital Control Systems, 2/e, Saunders College Publishing, Philadelphia, 1992.
2. C. L. Philips, H. T. Nagle, Digital Control Systems, Prentice-Hall, Englewood Cliffs, New Jersey, 1995.
3. M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill, 1997
4. Ogata K., Discrete-Time Control Systems, Pearson Education, Asia.

References:

1. Constantine H. Houpis and Gary B. Lamont, Digital Control Systems Theory, Hardware Software, McGraw Hill Book Company, 1985.
2. Isermann R., Digital Control Systems, Fundamentals, Deterministic Control, V. I, 2/e, Springer Verlag, 1989.
3. Liegh J. R., Applied Digital Control, Rinchart & Winston Inc., New Delhi.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Basic digital control system- Examples - mathematical model-ZOH and FOH- choice of sampling rate-principles of discretization - Mapping between s-domain and z-domain	7	15%
II	Pulse transfer function- Different configurations for the design- Modified z-transform-Time responses of discrete data systems-Steady state performance.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Digital PID and Compensator Design: Design of digital PID controller, Design of lag, lead compensators - based on frequency response method.	7	15%
IV	Digital Controller Design: Design based on root locus in the z-plane, direct design - method of Ragazzini. Dead-beat response design- Deadbeat controller.	7	15%
	SECOND INTERNAL EXAMINATION		
V	State variable model of discrete data systems -Various canonical form representations-controllable, observable, diagonal and Jordan forms-Conversion from state space to transfer function -Computation of state transition matrix using Cayley-Hamilton theorem and z-transform method	7	20%

VI	Digital state feedback controller design: Complete state and output Controllability, Observability, stabilizability and reachability - Loss of controllability and observability due to sampling.Pole placement design using state feedback for SISO systems.	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
EE463	Computer Aided Power Systems Analysis	3-0-0-3	2016

Prerequisite: EE306 Power system analysis

Course Objectives

- To introduce computer applications in the analysis of power systems
- To understand the solution methods and techniques used in power system studies

Syllabus:

Development of network matrices from Graph theory-Formulation of Bus Impedance matrices-Load Flow Analysis-Optimal Power Flow-Network fault calculations-Contingency analysis in Power systems.

Expected outcome:

- The students will gain the ability to critically analyse the solution methods used in power system studies.

Text Books:

1. Arthur R. Bergen, Vijay Vittal, Power Systems Analysis (English) 2nd Edition, Pearson Higher Education
2. G.L.Kusic, Computer Aided Power System Analysis, PHI, 1989
3. John J. Grainger, William D. Stevenson, Jr., Power System Analysis, Tata McGraw-Hill Series in Electrical and Computer Engineering.
4. M. A. Pai, Computer Techniques in Power Systems Analysis, Tata McGraw-Hill, Second edition 2005

References:

1. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", Tata McGraw Hill, 1980
2. J. Arriliga and N.R. Watson, Computer modelling of Electrical power systems, 2/e, John Wiley, 2001
3. LP. Singh, “Advanced Power System Analysis and Dynamics”, 3/e, New Age Intl, 1996.
4. Stagg and El Abiad, "Computer methods in Power system Analysis", McGraw Hill,1968.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Overview of Graph theory -tree, co-tree and incidence matrix, Development of network matrices from Graph theoretic approach. Review of solution of Linear System of equations by Gauss Jordan method, Gauss elimination, LDU factorization.	7	15%
II	Bus Reference Frame: Injections and Loads. Zbus and Y bus. Formulation of Bus Impedance matrix for elements without Mutual Coupling.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Inversion of YBUS for large systems using LDU factors, Tinney's Optimal ordering. Review of Gauss-Seidel Iteration using YBUS, Newton-Raphson method, Fast Decoupled Load Flow (FDLF) DC load flow, Three-phase Load Flow.	6	15%
IV	Adjustment of network operating conditions, Optimal power flow: concepts, active/reactive power objectives (Economic dispatch, MW and MVAr loss minimization) – applications- security constrained optimal power flow.	8	15%
	SECOND INTERNAL EXAMINATION		

V	Network fault calculations using ZBUS and YBUS Table of Factors, Algorithm for calculating system conditions after fault – three phase short circuit, three phase to ground, double line to ground, line to line and single line to ground fault.	7	20%
VI	Contingency analysis in Power systems : Contingency Calculations using ZBUS and YBUS Table of Factors. State estimation – least square and weighted least square estimation methods for linear systems.	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
EE464	Flexible AC Transmission Systems	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To introduce various Power Electronics controllers used in the Power Systems for the fast real and reactive power control.

Syllabus

Power flow control - Benefits of FACTS -Transmission line compensation. Uncompensated line - shunt and series compensation .Reactive power compensation . Static shunt and series compensators - Static Voltage and Phase Angle Regulators (TCVR &TCPAR). Switching Converter type shunt and series Compensators - principle of operation, configuration and control. Unified Power Flow Controller

Expected outcome .

The students will be able to:

- Understand various power electronics based FACTS devices for the control of active and reactive power in the system
- Understand the control schemes of various FACTS devices.

References:

1. Hingorani and L Gyugyi, “Understanding FACTS”, IEEE Press, 2000
2. J Arriliga and N R Watson, "Computer modeling of Electrical Power Systems”, Wiley, 2001 T J E Miller, "Reactive Power Control in Power Systems'', John Wiley, 1982
3. K R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International Publishers, 2007
4. Ned Mohan et. al "Power Electronics”, John Wiley and Sons.
5. Y.H. Song and A.T. Johns, “Flexible ac Transmission Systems (FACTS)”, IEE Press, 1999

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Power flow in Power Systems – Steady-state and dynamic problems in AC systems – Voltage regulation and reactive power flow control in Power Systems – control of dynamic power unbalances in Power System Power flow control -Constraints of maximum transmission line loading - Benefits of FACTS - Transmission line compensation: Compensation by a series capacitor connected at the midpoint of the line, Shunt Compensation connected at the midpoint of the line -Phase angle control	7	15%
II	Reactive power compensation – shunt and series compensation principles – reactive compensation at transmission and distribution level – Static versus passive VAr Compensators	6	15%
	FIRST INTERNAL EXAMINATION		
III	Static shunt Compensator - Objectives of shunt compensations, Methods of controllable VAR generation -		15%

	Variable impedance type VAR Generators -TCR , TSR, TSC, FC-TCR Principle of operation, configuration and control Static Series compensator - Objectives of series compensations, Variable impedance type series compensators - TCSC - Principle of operation, configuration and control.	8	
IV	Static Voltage and Phase Angle Regulators (TCVR & TCPAR): Objectives of Voltage and Phase angle regulators Thyristor controlled Voltage and Phase angle Regulators	7	15%
SECOND INTERNAL EXAMINATION			
V	Switching converter type shunt Compensators.- Principle of operation, configuration and control , Comparison between SVC and STATCOM- Applications Switching converter type Series Compensators-(SSSC)- Principle of operation, configuration and control	7	20%
VI	Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC General Equivalent Circuit for Facts Controllers (Shunt+series) Introduction to interline power flow controller.	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
EE465	Power Quality	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To discuss various power quality issues and different methods to control them.

Syllabus:

Power quality issues in distribution systems, Need for power quality monitoring, IEEE guides, standards and recommended practices, Modelling of networks and components under non sinusoidal conditions, Harmonic Analysis, Effects of Power System harmonics on Power System equipment and loads, Harmonic elimination, Power Quality Management in Smart Grid, Electromagnetic Interference.

Expected Outcome:

- The students will be able to identify the power quality problems, causes and suggest suitable mitigating techniques.

References:

1. Angelo Baggini (Ed.) *Handbook of Power Quality,* Wiley, 2008
2. C. Sankaran, *'Power Quality',* CRC Press, 2002
3. G. T. Heydt, *'Power Quality',* Stars in circle publication, Indiana, 1991
4. Jose Arillaga, Neville R. Watson, *'Power System Harmonics',* Wiley, 1997
5. Math H. Bollen, *'Understanding Power Quality Problems'* Wiley-IEEE Press, 1999
6. R. C. Durgan, M. F. Me Granaghen, H. W. Beaty, *'Electrical Power System Quality',* McGraw-Hill

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Power quality phenomenon - Sources and Effects of power quality problems, types of power quality disturbances - Voltage sag (or dip), Swell, Transients, short duration voltage variation, Long duration voltage variation, voltage imbalance, waveform distortion, and voltage flicker	6	15%
II	IEEE guide lines, standards and recommended practices. Harmonics -mechanism of harmonic generation-harmonic indices (THD, TIF, DIN, C – message weights - Power Quality Costs Evaluation -. Harmonic sources – Switching devices, arcing devices, saturable devices. Effects of Power System harmonics on Power System equipment and loads.	7	15%
FIRST INTERNAL EXAMINATION			
III	Harmonic Analysis - Fourier series and coefficients, the Fourier transforms, discrete Fourier transform, fast Fourier transform, Window function- numerical problems. .	5	15%
IV	Power quality Monitoring considerations: Power line disturbance analyzer, power quality measurement equipment, harmonic spectrum analyzer, flicker meters, disturbance analyzer	7	15%
SECOND INTERNAL EXAMINATION			

V	Harmonic elimination - Design and analysis of filters to reduce harmonic distortion – Power conditioners ,passive filter, active filter - shunt , series, hybrid filters,	7	20%
VI	Power Quality Management in Smart Grid: Power Quality in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid. Electromagnetic Interference (EMI -introduction - Frequency Classification - Electrical fields-Magnetic Fields - EMI Terminology - Power frequency fields - High frequency	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 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
EE467	Nonlinear Control Systems	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To introduce the need and concept of nonlinear system.
- To impart knowledge about different strategies adopted in the analysis of nonlinear systems.
- To familiarize with the design of different types of nonlinear controllers.

Syllabus:

Characteristics of nonlinear systems- equilibrium points-phase plane analysis-periodic orbits-stability of nonlinear systems-Lyapunov stability-variable gradient method-centre manifold theorem-circle criterion-Popov criterion-Feedback linearization-Exact Feedback linearization.

Expected outcome

The students will be able to

i. design controllers for nonlinear systems.
ii. analyse the stability of nonlinear systems using various approaches.

Text Books:

1. Alberto Isidori, "*Nonlinear Control Systems: An Introduction*", Springer-Verlag, 1985
2. Hassan K Khalil, Nonlinear Systems, Prentice - Hall International (UK), 2002.
3. Jean-Jacques E. Slotine and Weiping Li, "*Applied Nonlinear Control*", Prentice-Hall, NJ, 1991.

References:

1. M. Vidyasagar, "*Nonlinear Systems Analysis*", Prentice-Hall, India, 1991,
2. Shankar Sastry, "*Nonlinear System Analysis, Stability and Control*", Springer, 1999.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction - Characteristics of nonlinear systems - Classification of equilibrium points- analysis of systems with piecewise constant inputs using phase plane analysis.	7	15%
II	Periodic orbits - limit cycles-Poincare-Bendixson criterion-Bendixson criterion. Existence and uniqueness of solutions, Lipschitz condition.	7	15%
FIRST INTERNAL EXAMINATION			
III	Stability of Nonlinear Systems - Lyapunov stability - local stability - local linearization and stability in the small- Direct method of Lyapunov - generation of Lyapunov function for linear and nonlinear systems – variable gradient method.	7	15%
IV	Centre manifold theorem - region of attraction - Feedback Control and Feedback Stabilisation-Analysis of feedback systems- Circle Criterion – Popov Criterion.	7	15%
SECOND INTERNAL EXAMINATION			

V	Feedback linearization- Design via linearization- stabilization - regulation via integral control- gain scheduling.	7	20%
VI	Exact Feedback Linearization - Input state linearization - input output linearization - state feedback control - stabilization - tracking - integral control.	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
EE468	Computer Networks	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart the mode of operation of different types of computer networks that are used to interconnect a distributed community of computers and various interfacing standards and protocols

Syllabus

Introduction on Computer Networks, Network Hardware, Protocol architecture, functionalities, MAC protocols, Network layer, Transport layer, Application Layer

Expected Outcome.

The students will be able to:

i. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
ii. Specify and identify deficiencies in existing protocols, and then go onto formulate new and better protocols.
iii. Analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.

Text Book:

1. Jim Kurose and Keith Ross, ``Computer Networking: A Top-Down Approach," 5th Edition, Pearson Education, 2012
2. Larry L. Peterson and Bruce S. Davie , ``Computer Networks: A Systems Approach," Morgan Kaufmann, 5/e, 2011

References:

1. Andrew S, Computer Networks by Tanenbaum, Prentice Hall of India, New Delhi
2. Foronzan, Data Communications and Networking, Tata McGraw Hill, New Delhi
3. Neil Jenkins, Understanding Local area Network, SAMS Publishers
4. Peter Hudson, Local area Networks by, Thomson Learning

Course Plan

Module	Contents	Hours	Sem.ExamMarks
I	Introduction-Uses of Computer Networks, Network Hardware, Network Software, Reference Models, Example Networks,	6	15%
II	Network Standardization. The Medium Access Control Sublayer- The Channel Allocation Problem, Multiple Access Protocols, Ethernet, Wireless LANs, Broadband Wireless, Bluetooth.	7	15%
	FIRST INTERNAL EXAMINATION		
III	The Network Layer- Network Layer Design Issues, Routing Algorithms, Congestion Control Algorithms, Quality of Service, Internetworking, The Network Layer in the Internet	7	15%

IV	The Transport Layer- The Transport Service, Elements of Transport Protocols, A Simple Transport Protocol,	7	15%
SECOND INTERNAL EXAMINATION			
V	The Internet Transport Protocols: UDP, The Internet Transport Protocols: TCP, Performance Issues.	7	20%
VI	The Application Layer- DNS-The Domain Name System, Electronic Mail, The World Wide Web, Multimedia	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 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
EE469	Electric and Hybrid Vehicles	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To present a comprehensive overview of Electric and Hybrid Electric Vehicles

Syllabus

Introduction to Hybrid Electric Vehicles, Conventional Vehicles, Hybrid Electric Drive-trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor, Energy Storage Requirements in Hybrid and Electric Vehicles, Sizing the drive system, Design of a Hybrid Electric Vehicle , Energy Management Strategies.

Expected outcome.

The students will be able to

i. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
ii. Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
iii. Choose proper energy storage systems for vehicle applications
iv. Identify various communication protocols and technologies used in vehicle networks.

Text Book:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

References:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	7	15%
II	Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	7	15%
FIRST INTERNAL EXAMINATION			
III	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives	7	15%
IV	Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.	7	15%
SECOND INTERNAL EXAMINATION			
V	Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power	7	20%

	electronics, selecting the energy storage technology,		
VI	Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies	**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
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.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE474	ENERGY MANAGEMENT AND AUDITING	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To enable the students to understand the concept of energy management and energy management opportunities
- To understand the different methods used to control peak demand
- To know energy auditing procedure
- To understand the different methods used for the economic analysis of energy projects.

Syllabus

General principles of Energy management and Energy management planning - Peak Demand controls - Energy management opportunities in electrical systems and HVAC systems – Reactive power management – Energy audit – cogeneration system – Economic analysis of energy projects

Expected outcome .

- The students will be able to understand the different methods used to reduce energy consumption

Data Book (Approved for use in the examination):

References:

1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003.
2. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons, 1996.
3. Craig B. Smith, Energy management principles, Pergamon Press.
4. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2007
5. G.G. Rajan, Optimizing energy efficiencies in industry -, Tata McGraw Hill, Pub. Co., 2001.
6. IEEE recommended practice for energy management in industrial and commercial facilities,
7. IEEE std 739 - 1995 (Bronze book).
8. M Jayaraju and Premlet, Introduction to Energy Conservation And Management, Phasor Books, 2008
9. Paul O'Callaghan, Energy management, McGraw Hill Book Co.
10. Wayne C. Turner, Energy management Hand Book - - The Fairmount Press, Inc., 1997.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load scheduling-Case studies.	6	15%
II	Energy management opportunities in Lighting and Motors. Electrolytic Process and Electric heating, Case studies.	8	15%
	FIRST INTERNAL EXAMINATION		
III	Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler.		

	Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.	8	15%
IV	HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities	7	15%
SECOND INTERNAL EXAMINATION			
V	Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study. Computer aided energy management.	7	20%
VI	Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.	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.

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE474	ENERGY MANAGEMENT AND AUDITING	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To enable the students to understand the concept of energy management and energy management opportunities
- To understand the different methods used to control peak demand
- To know energy auditing procedure
- To understand the different methods used for the economic analysis of energy projects.

Syllabus

General principles of Energy management and Energy management planning - Peak Demand controls - Energy management opportunities in electrical systems and HVAC systems – Reactive power management – Energy audit – cogeneration system – Economic analysis of energy projects

Expected outcome .

- The students will be able to understand the different methods used to reduce energy consumption

Data Book (Approved for use in the examination):

References:

1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003.
2. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons, 1996.
3. Craig B. Smith, Energy management principles, Pergamon Press.
4. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2007
5. G.G. Rajan, Optimizing energy efficiencies in industry -, Tata McGraw Hill, Pub. Co., 2001.
6. IEEE recommended practice for energy management in industrial and commercial facilities,
7. IEEE std 739 - 1995 (Bronze book).
8. M Jayaraju and Premlet, Introduction to Energy Conservation And Management, Phasor Books, 2008
9. Paul O'Callaghan, Energy management, McGraw Hill Book Co.
10. Wayne C. Turner, Energy management Hand Book - - The Fairmount Press, Inc., 1997.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load scheduling-Case studies.	6	15%
II	Energy management opportunities in Lighting and Motors. Electrolytic Process and Electric heating, Case studies.	8	15%
	FIRST INTERNAL EXAMINATION		
III	Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler.		

	Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.	8	15%
IV	HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities	7	15%
SECOND INTERNAL EXAMINATION			
V	Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study. Computer aided energy management.	7	20%
VI	Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.	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.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE484	Control Systems	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To know Mathematical modelling of physical systems.
- To impart sound knowledge on different control equipment.
- To analyse systems using mathematical model.

Syllabus

Linear Time Invariant systems: Open loop-and closed loop control systems, Transfer function: Mechanical, Electromechanical systems. block diagram representation, signal flow graph. Control system components. Time domain analysis of control systems. PID controllers, Concept of stability, Frequency domain analysis, Introduction to State space.

Expected outcome.

The students will be able to

i. Model systems in transfer function and state space domain and
ii. Analyse stability of linear time invariant systems.

Text Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Fourth edition, Pearson Education, New Delhi, 2002.
2. Nagarath I.J. and Gopal M., "Control System Engineering", Wiley Eastern, New Delhi.
3. Richard C. Dorf, Robert. H. Bishop, "Modern Control Systems", Pearson Education, New Delhi, 11th Edition, 2007.

References:

1. Gibson & Tutter, "Control System Components", Mc Graw Hill.
2. Kuo B.C., "Automatic Control Systems", Prentice Hall of India, New Delhi, sixth edition, 1991.
3. Norman S. Nise ,"Control Systems Engineering", 5th Edition, Wiley Eastern, 2007.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Open loop-and closed loop control systems: Transfer function -T.F of simple linear time invariant systems - Mechanical and Electromechanical systems – Force voltage and force current analogy - block diagram representation - block diagram reduction - signal flow graph - Mason's gain formula - characteristics equation.	9	15%
II	Control system components: DC and AC servo motor – synchro - magnetic amplifier - gyroscope - stepper motor - Tacho meter.	5	15%
	FIRST INTERNAL EXAMINATION		
III	Time domain analysis of control systems: Transient and steady state responses - test signals - time domain specifications - first and second order systems - impulse and step responses - steady state error analysis - static error coefficient of type 0,1,2 systems - Dynamic error coefficients	7	15%
IV	PID controllers, Concept of stability: stability of feedback system - Routh's stability criterion - Root locus -General rules for constructing Root loci - effect of addition of poles and zeros.	7	15%
	SECOND INTERNAL EXAMINATION		
V	Frequency domain analysis: Introduction - Bode plot -Polar plot- gain margin - phase margin.	6	20%

VI	Introduction to state space: State concept, state equation of simple systems, physical and phase variables, Eigen value and eigenvectors, conversion of state space model to transfer function.	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 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
EE486	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. Learn the unified and exact mathematical basis as well as the general principles of various soft computing techniques.

Text Books:

1. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Pearson Edn.,
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India,
3. S.Y Kung, Digital Neural Network-, 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	7	15%

	Sets – Fuzzy Relations - Fuzzy Rules and Fuzzy Reasoning		
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 code	Course Name	L-T-P - Credits	Year of Introduction
EE488	INDUSTRIAL AUTOMATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To explain the General function of Industrial Automation
- To identify Practical Programmable Logic Controller Applications
- To know Industrial Sensors and Robotics

Syllabus

Types of motion actuators, electrical and mechanical sensors, ladder diagrams, cascade method, Huffman method, Programmable Logic Controllers, Microcomputers: interfacing and programming, Principles of Robotics and applications

Expected outcome .

The students will

i. Know about motion devices in automation
ii. Know about various sensors in automation
iii. Be able to draw ladder diagrams for applications
iv. Be able to understand assembly language programs
v. Know about Robotic components

Text Book:

- Pessen, Industrial Automation : Circuit Design and Components, Wiley

References:

1. Bartelt, Industrial Automated Systems, Instrumentation and Motion Control, Cengage
2. Mukhopadyay et al, Industrial Instrumentation, Control and Automation, Jaico Publishing House

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Motion Actuators: Types of Motion and Motion Conversion, Electric Linear Actuators, Electric Rotary Actuators, Fluid-Power Linear Actuators, Fluid-Power Rotating Actuators	6	15%
II	Sensors : Binary vs. analog sensors, Electric Position sensors: Limit switches, photovoltaic sensors, ultrasonic sensors, inductive and capacitive and magnetic proximity sensors, Pneumatic position sensors: limit valves, back-pressure sensors, coiled spring sensors. Level, pressure, temperature and flow switches	6	15%
	FIRST INTERNAL EXAMINATION		
III	Electric Ladder Diagrams: Ladder diagrams, sequence charts, Ladder diagram design using sequence charts, cascade method,: single and multi path sequencing systems with and without sustained outputs, Huffman method: sequential systems, stable and unstable states, state assignment.	7	15%
IV	Programmable Controllers: PLC construction, Programming the PLC, constructing ladder diagrams for PLCs,	7	15%

SECOND INTERNAL EXAMINATION			
V	Microcomputers : Microcomputers for control applications, architecture, computer interfacing, programmable interface adaptors, Ramping a step motor example.	8	20%
VI	Robotics and Numerical Control : Basic Robot Definitions, Basic manipulator configurations, Numerical Control Systems, Robot Kinematics, Robot Grippers, Robot Sensors, Robot Programming, General Considerations for Robot Applications	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 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
EE492	Instrumentation Systems	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To introduce the measurement techniques for measurement of mechanical quantities
- To introduce different types of electronic circuits for measurements and their applications.

Syllabus

General Concepts ,Generalised Configurations and Functional Description of Measuring Instruments, Measuring Devices, Force and Torque Measurements, Shaft Power Measurements, Pressure and Sound Measurements, Dynamic Testing of Pressure-Measuring Systems, Flow Measurement, Temperature Measurement, Bridge Circuits ,Amplifiers ,Filters, Integration and Differentiation, Voltage-Indicating and Recording Devices, Electromechanical Servo type XT and XY Recorders.

Expected outcome.

The students will have the

i. Ability to understand and analyze Instrumentation systems.

ii. Ability to select proper measurement system for various applications.

Text Book:

- Ernest O Doebelin and Dhanesh N Manik, Measurement Systems, Mc Graw Hill, 6e.

References:

1. Neubert, Instrument Transducers, Oxford University Press.
2. Turner and Hill, Instrumentation for Engineers and Scientists, Oxford University Press

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General Concepts : Need for Measurement Systems, Classification of Types of Measurements Applications Generalised Configurations and Functional Description of Measuring Instruments : Functional Elements of an Instrument , Active and Passive Transducers , Analog and Digital Modes of Operation ,Null and Deflection Methods, Input-Output Configurations of Instruments and Measurement Systems	7	15%
II	Measuring Devices : Motion Measurements : Fundamental Standards, Relative Displacements : Translational and Rotational , Relative Velocity : Translational and Rotational, Relative-Acceleration Measurements Force and Torque Measurements : Standards and calibration , Basic Methods of Force Measurements , Characteristics of Elastic Force Transducers ,Torque Measurement on Rotating Shafts	7	15%
FIRST INTERNAL EXAMINATION			
III	Shaft Power Measurements : Shaft Power Measurements (Dynamometers), Vibrating-Wire Force Transducers Pressure and Sound Measurements: Standards and Calibration , Basic Methods of Pressure Measurements, Deadweight Gages and Manometers , Elastic Transducers, Vibrating-Cylinder and	7	15%

	Other Resonant Transducers		
IV	Dynamic Testing of Pressure-Measuring Systems, High Pressure Measurement, Low Pressure(Vacuum) Measurement, Sound Measurements Flow Measurement : Local Flow Velocity , Magnitude and Direction , Gross Volume Flow Rate	7	15%
SECOND INTERNAL EXAMINATION			
V	Temperature Measurement : Standards and Calibration , Thermal-Expansion Methods ,Thermoelectric Sensors (Thermocouples), Electric-Resistance Sensors, Junction Semiconductor Sensors ,Digital Thermometers ,Radiation Methods	7	20%
VI	Bridge Circuits ,Amplifiers ,Filters, Integration and Differentiation Voltage-Indicating and Recording Devices : Standards and Calibration , Analog Voltmeters and Potentiometers Electrical Instruments : RMS Voltmeter , Ohm Meter , Phase Meter , Q Meter Digital Voltmeters and Multimeters , Signal Generation, Square Wave Generation , Electromechanical Servo type XT and XY Recorders	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.