Course No.	Course name	L-T-P - Credits	year of Introduction
EE301	POWER GENERATION, TRANSMISSION AND PROTECTION	3-1-0-4	2015

Course Objectives

The objective of this course is to set a firm 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 course will enable the students to learn the basic aspects in the area of power generation, transmission, distribution and protection.

The student will be able to 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. Wadhwa, "Electrical Power system", Wiley Eastern Ltd. 2005
3. J.B. Gupta, "A course in Electrical Power", Katharia and sons, 2004.

References

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

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.	6	15%
II	**Power Transmission** **Transmission Line Parameters:** Resistance, inductance and capacitance of 1-Φ, 2 wire lines-composite conductors (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	10	15%
	FIRST INTERNAL EXAM		
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 EXAM		

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. **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	20%
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	7	20%
END SEMESTER EXAM			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**

  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**

  Maximum Marks: 100 Exam Duration: 3Hrs.

QUESTION PAPER PATTERN:

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: 8 questions

3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE303	**Linear Control Systems**	**3-0-0**	**2015**

Course Objectives: The objective of this course is 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.

On successful completion ,students will have the

1. Ability to develop mathematical models of various systems.
2. Ability to analyse the stability aspects of linear time invariant systems.

Text Book:

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

Data Book (Approved for use in the examination):

References:

1) Kuo B. C., Automatic Control Systems, Prentice Hall of India, New Delhi, 2002.
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.

Course Plan

Module	Contents	Hours	Sem.ExamMarks
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 hrs	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 hrs	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 hrs	15%
IV	Root locus - General rules for constructing Root loci – stability from root loci - effect of addition of poles and zeros.	7 hrs	15%
	SECOND INTERNAL EXAMINATION		
V	Frequency domain analysis: Frequency domain specifications-Analysis based on Bode plot - Log magnitude vs. phase plot,	7 hrs	20%
VI	Polar plot- Nyquist stability criterion-Nichols chart - Non-minimum phase system - transportation lag.	7 hrs	20%

END SEMESTER EXAM

EVALUATION SCHEME

- **INTERNAL EVALUATION:**

  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**

  Maximum Marks: 100 Exam Duration: 3Hrs.

QUESTION PAPER PATTERN:

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: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE 305	Power Electronics	3-0-0-3	2015

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.

Students who successfully complete this course will be able to:

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

Text Book:

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

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

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 hrs	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 equation – 1-phase half controlled bridge rectifier with R, RL and RLE loads – displacement power factor – distortion factor.	8 hrs	15%
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 hrs	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 hrs	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 hrs	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 hrs	20%
END SEMESTER EXAM			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**
  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**
  Maximum Marks: 100 Exam Duration: 3 hrs

QUESTION PAPER PATTERN:

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 x 5) = 40

Part B: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3 = 60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE 307	SIGNAL AND SYSTEMS	3-0-0-3	2015

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:

1. Represent various signals and systems
2. Analyse the continuous time system with Laplace transform
3. Represent and analyse signals using Fourier representation
4. Analyse the discrete time system using ZT
5. Analyse the DT systems with DFS
6. 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 Mc Graw Hill

References:

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

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	**Module II (15 hours)** Fourier representation of continuous time signals –Fourier Series-Harmonic analysis of common signals- Fourier transform - Existence –properties of FT- Energy spectral density and power spectral density - Frequency response of LTI systems -	7	15%
IV	Sampled data systems- Sampling process-sampling theorem- signal re construction- Zero order and First order hold circuits- Difference equation representations of LTI systems -	7	15%

	Discrete form of special functions- Discrete convolution and its properties		
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			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**

  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**

  Maximum Marks: 100 Exam Duration: 3Hrs.

QUESTION PAPER PATTERN:

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: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE 309	Microprocessor and Embedded Systems	3-0-0-3	2015

Course Objectives

The objective of this course is 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 student will be able to:

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

Text books:

1. Ramesh Gaonkar, Microprocessor, Architecture, Programming and Applications, Penram International Publishing; Sixth edition, 2014.
2. Mathur A., Introduction to Microprocessors, Tata McGraw Hill, New Delhi, 1992.
3. Douglas V. Hall, Microprocessors and Interfacing, Tata McGraw Hill, Education, New Delhi, Third Edition.
4. Rafiquzzaman, Microprocessor Theory and Application, PHI Learning, First Edition. 7. Ray Ajoy and Burchandi, Advanced Microprocessor & Peripherals, Tata McGraw Hill, Education, New Delhi, Second Edition.
5. Mohamed Ali Mazidi,Janice Gillispie Mazidi," The 8051 microcontroller and embedded systems using Assembly and C",second edition, Pearson education /Prentice hall of India
6. 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	**Module II (15 hours)** 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			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**

  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**

  Maximum Marks: 100 Exam Duration: 3Hrs.

QUESTION PAPER PATTERN:

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: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P - Credits	Year of Introduction
EE 321	Digital Circuits and Embedded Systems Lab	0-0-3-1	2015

Course Objectives

Impart practical knowledge for 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)

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)**

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.

Students are expected to design, setup and analyse various digital circuits. They should also be able to design an embedded system for a particular application

Course No.	Course Name	L-T-P - Credits	Year of Introduction
EE 323	Electrical Machines Lab II	0-0-3-1	2015

Course Objectives

To conduct various tests on 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 in lab

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 No.	Course Name	L-T-P -Credits	Year of Introduction
EE 361	**Object Oriented Programming**	**3-0-0-3**	**2015**

Course Objectives

To familiarize the student with the Object Oriented Programming Concepts

Also 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.

Able to develop simple application using object oriented concepts and Java

Text Book:

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

Data Book (Approved for use in the examination):

References:

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

Course Plan

Module	Contents	Hours	Sem.ExamMarks
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		

EVALUATION SCHEME

- **INTERNAL EVALUATION:**
  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS :30
- **EXTERNAL EVALUATION:**
  Maximum Marks: 100 Exam Duration: 3 Hrs

QUESTION PAPER PATTERN:

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: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE 363	**Computer Organization and Design**	**3-0-0-3**	**2015**

Course Objectives

To lay the foundation for the study of hardware organization of digital computers.

To bring out 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.

Expected to gain a fair idea about the functional aspects of each building block in computer design, in the general sense

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

Data Book (Approved for use in the examination):

References:

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

Course Plan

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

END SEMESTER EXAM

EVALUATION SCHEME

- **INTERNAL EVALUATION:**
  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**
  Maximum Marks: 100 Exam Duration: 3 hrs

QUESTION PAPER PATTERN:

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: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE 365	Digital System Design	3-0-0-3	2015

Course Objectives

To make students able to design and build real digital circuits

To make students able to do VHDL programming

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 student must be able to

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

Text Book:

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

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

References:

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

Course Plan

Module	Contents	Hours	Sem.ExamMarks
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 ,Testbenches, Configurations Combinational Building Blocks : Three-Stat Buffers , Decoders ,Multiplexers, Priority Encoders , Adders, Parity Checkers , Testbenches for Combinational blocks	9	15%
	FIRST INTERNAL EXAMINATION		
III	Synchronous Sequential Design : Synchronous Sequential Systems , Models of Synchronous Sequential Systems, Algorithmic State Machines ,Synthesis from ASM chart ,	8	15%

	State Machines in VHDL , VHDL Testbenches for State Machines		
IV	VHDL Models of Sequential Logic Blocks : Latches , Flip-Flops , J K and T Flip Flop , Registers and Shift Registers ,Counters , Memory, Sequential Multiplier, Testbenches 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			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**
  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30
- **EXTERNAL EVALUATION:**
  Maximum Marks: 100 Exam Duration: 3 hrs

QUESTION PAPER PATTERN:

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: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE367	New and Renewable Sources of Energy	3-0-0	2016

Course Objectives:
This subject provides sufficient knowledge about the promising new and renewable sources of energy so as to equip students capable of working with projects related to its aim 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:
Upon successful completion of this course, students will be able to design and analyse the performance of small isolated renewable energy sources.

References:

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

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.	4	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 and characteristics – Flat plate collectors – Heat	11	15%

	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			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**

  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**

Maximum Marks: 100 Exam Duration: 3Hrs.

QUESTION PAPER PATTERN:

Part A: 8 questions.
One question from each module of Module I - IV; and two each from Module V & VI.
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Part B: 8 questions
3 questions from each 2 module set; at least one question from each module.
Student has to answer any 2 from 3 questions: (2 x 10) x 3=60

Course No.	Course Name	L-T-P -Credits	Year of Introduction
EE 369	**High Voltage Engineering**	**3-0-0**	

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-nondestructive testing techniques- testing of power equipments, design of testing lab and grounding of laboratories

Expected outcome.

Students who successfully complete this course should be aware of 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:

- Naidu M.S. and Kamaraju V., "High voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
- Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India P Ltd, 2005

Dieter Kind, Kurt Feser, "High voltage test techniques", SBA Electrical Engineering Series, New Delhi, 1999.

Course Plan

Module	Contents	Hours	Sem.ExamMarks
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 hours	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 hours	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 hours	15%
IV	Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method – voltage dividers and impulse voltage measurements- measurement of impulse currents	7 hours	15%
	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-	7 hrs	15%

	Basic partial discharge(PD) circuit – PD currents- PD quantities - Corona and RIV measurements		
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 hrs	15%
END SEMESTER EXAM			

EVALUATION SCHEME

- **INTERNAL EVALUATION:**

  MARKS FOR ASSIGNMENTS/SEMINARS/PROJECTS/CASE STUDY: 20

  MARKS FOR TESTS : 30

- **EXTERNAL EVALUATION:**

  Maximum Marks: 100 Exam Duration: 3hours

QUESTION PAPER PATTERN:

Part A: 8 questions.

One question from each module of Module I - IV; and two each from Module V & VI.
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Part B: 8 questions

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Student has to answer any 2 from 3 questions: (2 x 10) x 3=60