



1.3.2. Average percentage of courses that include experiential learning through project work/field work/internship during last five years

**ELECTRICAL & ELECTRONICS
ENGINEERING Document contains list and
syllabus of courses that includes experiential
learning through project works and internships**

RAJARAJESWARI COLLEGE OF ENGINEERING

Approved by AICTE, New Delhi.

Affiliated to the Visvesvaraya Technological University, Belagavi



Criteria: 1 Academic Year: 2016-2021



Documents Enclosed

Sl.No	Particulars	Page No
1	List of course that include experiential learning	
2	Syllabus of mapped course	
3	List of project work	
4	Project work completion certificates	
5	List of internships undertaken by students	
6	Internship completion certificates	



LIST OF COURSE THAT INCLUDE EXPERIENTIAL LEARNING

SI NO	Course Code	Course Name
1.	18ELE23	Basic Electrical Engineering
2.	18EEL27	Basic Electrical Engineering Lab
3.	18EE32	Electric Circuit Analysis
4.	18EE33	Transformers and Generators
5.	18EE34	Analog Electronic Circuits
6.	18EE35	Digital System Design
7.	18EEL37	Electrical Machines Laboratory -I
8.	18EEL38	Electronics Laboratory
9.	18EE44	Electric Motor
10.	18EE45	Electromagnetic Field Theory
11.	18EE46	Operational Amplifiers and Linear ICs
12.	18EEL47	Electrical Machines Laboratory -2
13.	18EE52	Microcontroller
14.	18EE53	Power Electronics
15.	18EEL57	Microcontroller Laboratory
16.	18EEL58	Power Electronics Laboratory
17.	18EE61	Control Systems
18.	18EE62	Power System Analysis-1
19.	18EE643	CAED(Computer Aided Electrical Drawing)
20.	18EEL66	Control Systems Lab
21.	18EEL67	Digital Signal Processing Lab
22.	17EE71	Power system analysis-2
23.	17EE72	Power System Protection
24.	17EE742	Electrical Power Utilization
25.	17EEL76	Power system simulation Lab
26.	17EEL77	Relay & High voltage Lab
27.	17EEP78	Project Phase 1
28.	17EE81	Power system operation and control
29.	17EE82	Industrial Drives and Applications
30.	17EE832	Operation & Maintenance of Solar Electric Systems
31.	17EE84	Internship/ Professional Practice

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32.	17EEP85	Project Work Phase II
33.	17EES86	Seminar

Syllabus of Mapped Courses

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - III			
ELECTRIC CIRCUIT ANALYSIS			
Course Code	18EE32	CIE Marks	40
Teaching Hours/Week (L: T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To familiarize the basic laws, source transformations, theorems and the methods of analyzing electrical circuits. To explain the use of network theorems and the concept of resonance. To familiarize the analysis of three-phase circuits, two port networks and networks with non-sinusoidal inputs. To explain the importance of initial conditions, their evaluation and transient analysis of R-L and R-C circuits. To impart basic knowledge on network analysis using Laplace transforms. ■ 			
Module-1			
Basic Concepts: Active and passive elements, Concept of ideal and practical sources. Source transformation and Source shifting, Concept of Super-Mesh and Super node analysis. Analysis of networks by (i) Network reduction method including star – delta transformation, (ii) Mesh and Node voltage methods for ac and DC circuits with independent and dependent sources. Duality. ■			
Module-2			
Network Theorems: Super Position theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem and Millman's theorem. Analysis of networks, with and without dependent ac and DC sources. ■			
Module-3			
Resonant Circuits: Analysis of simple series RLC and parallel RLC circuits under resonances. Problems on Resonant frequency, Bandwidth and Quality factor at resonance Transient Analysis: Transient analysis of RL and RC circuits under DC excitations: Behavior of circuit elements under switching action ($t = 0$ and $t = \infty$), Evaluation of initial conditions. ■			
Module-4			
Laplace Transformation: Laplace transformation (LT), LT of Impulse, Step, Ramp, Sinusoidal signals and shifted functions. Waveform synthesis. Initial and Final value theorems. ■			
Module-5			
Unbalanced Three Phase Systems: Analysis of three phase systems, calculation of real and reactive Powers by direct application of mesh and nodal analysis. Two Port networks: Definition, Open circuit impedance, Short circuit admittance and Transmission parameters and their evaluation for simple circuits, relationships between parameter sets. ■			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and reduce the complexity of network using source shifting, source transformation and network reduction using transformations. Solve complex electric circuits using network theorems. Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation. Synthesize typical waveforms using Laplace transformation. Solve unbalanced three phase systems and also evaluate the performance of two port networks. ■ 			
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question is for 20 marks. There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. Each full question with sub questions will cover the contents under a module. Students will have to answer 5 full questions, selecting one full question from each module. ■ 			
Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher
Textbooks			
Edition and Year			

1	Engineering Circuit Analysis	William H Hayt et al	Mc Graw Hill	8th Edition,2014
2	Network Analysis	M.E. Vanvalkenburg	Pearson	3rd Edition,2014
3	Fundamentals of Electric Circuits	Charles K Alexander Matthew N O Sadiku	Mc Graw Hill	5th Edition,2013
Reference Books				
1	Engineering Circuit Analysis	J David Irwin et al	Wiley India	10th Edition, 2014
2	Electric Circuits	Mahmood Nahvi	Mc Graw Hill	5th Edition, 2009
3	Introduction to Electric Circuits	Richard C Dorf and James A Svoboda	Wiley	9 th Edition, 2015
4	Circuit Analysis; Theory and Practice	Allan H Robbins Wilhelm C Miller	Cengage	5 th Edition, 2013
5	Basic Electrical Engineering	V K Mehta, Rohit Mehta	S Chand	6 th Edition 2015

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - III			
TRANSFORMERS AND GENERATORS			
Subject Code	18EE33	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To understand the concepts of transformers and their analysis. To suggest a suitable three phase transformer connection for a particular operation. To understand the concepts of generator and to evaluate their performance. To explain the requirement for the parallel operation of transformers and synchronous generators. ■ 			
Module-1			
Single phase Transformers: Operation of practical transformer under no-load and on-load with phasor diagrams. Open circuit and Short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency-commercial and all-day efficiency. Voltage regulation and its significance. Three-phase Transformers: Introduction, Constructional features of three-phase transformers. Choice between single unit three-phase transformer and a bank of three single-phase transformers. Transformer connection for three phase operation– star/star, delta/delta, star/delta, zigzag/star and V/V, comparative features. Phase conversion-Scott connection for three-phase to two-phase conversion. Labeling of three-phase transformer terminals, vector groups.■			
Module-2			
Tests, Parallel Operation of Transformer & Auto Transformer: Polarity test, Sumpner's test, separation of hysteresis and eddy current losses Parallel Operation of Transformers: Necessity of Parallel operation, conditions for parallel operation– Single phase and three phase. Load sharing in case of similar and dissimilar transformers. Auto transformers and Tap changing transformers: Introduction to autotransformer-copper economy, equivalent circuit, no load and on load tap changing transformers. ■			
Module-3			
Three-Winding Transformers & Cooling of Transformers: Three-winding transformers. Cooling of transformers. Direct current Generator: Armature reaction, Commutation and associated problems, Synchronous Generators: Armature windings, winding factors, e.m.f equation. Harmonics–causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit.■			
Module-4			
Synchronous Generators Analysis: Alternator on load. Excitation control for constant terminal voltage. Voltage regulation. Open circuit and short circuit characteristics, Assessment of reactance-short circuit ratio, synchronous reactance, Voltage regulation by EMF, MMF and ZPF ■			
Module-5			
Synchronous Generators (Salient Pole): Effects of saliency, two-reaction theory, Parallel operation of generators and load sharing. Methods of Synchronization, Synchronizing power, Determination of X_d & X_q – slip test Performance of Synchronous Generators: Power angle characteristic (salient and non salient pole), power angle diagram, reluctance power, Capability curve for large turbo generators. Hunting and damper windings. ■			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Understand the construction and operation of 1-phase, 3-Phase transformers and Autotransformer. Analyze the performance of transformers by polarity test, Sumpner's Test, phase conversion, 3-phase connection, and parallel operation. Understand the construction and working of AC and DC Generators. Analyze the performance of the AC Generators on infinite bus and parallel operation. Determine the regulation of AC Generator by Slip test, EMF, MMF, and ZPF Methods. ■ 			

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Books

1	Electric Machines	D. P. Kothari, et al	McGraw Hill	4 th Edition, 2011
2	Principals of Electrical Machines	V.K Mehta, Rohit Mehta	S Chand	2 nd edition, 2009

Reference Books

1	Electric Machines	Mulukuntla S. Sarma, et al	Cengage	1 st Edition, 2009
2	Electrical Machines, Drives and Power systems	Theodore Wildi	Pearson	6 th Edition, 2014
3	Electric Machines	Ashfaq Hussain	Dhanpat Rai & Co	2nd Edition, 2013

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - III			
ANALOG ELECTRONIC CIRCUITS			
Subject Code	18EE34	CIE Marks	40
Number of Lecture Hours/Week	2:2:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none">Provide the knowledge for the analysis of diode and transistor circuits.Develop skills to design the electronic circuits like amplifiers and oscillators. ■			
Module-1			
Diode Circuits: Diode clipping and clamping circuits. Transistor Biasing and Stabilization: Operating point, analysis and design of fixed bias circuit, self- bias circuit, Emitter stabilized bias circuit, voltage divider bias circuit, stability factor of different biasing circuits. Problems. Transistor switchingcircuits. ■			
Module-2			
Transistor at Low Frequencies: BJT transistor modelling, CE fixed bias configuration, voltage divider bias, emitter follower, CB configuration, collector feedback configuration, analysis using h – parameter model, relation between h – parameters model of CE, CC and CB modes, Millers theorem and its dual. ■			
Module-3			
Multistage Amplifiers: Cascade and cascade connections, Darlington circuits, analysis and design. Feedback Amplifiers: Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits. ■			
Module-4			
Power Amplifiers: Amplifier types, analysis and design of different power amplifiers, Oscillators: Principle of operation, analysis and derivation of frequency of oscillation of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator and frequency stability. ■			
Module-5			
FETs: Construction, working and characteristics of JFET and MOSFET. Biasing of JFET and MOSFET. Analysis and design of JFET (only common source configuration with fixed bias) and MOSFET amplifiers ■			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">Obtain the output characteristics of clipper and clamper circuits.Design and compare biasing circuits for transistor amplifiers & explain the transistor switching.Explain the concept of feedback, its types and design of feedback circuitsDesign and analyze the power amplifier circuits and oscillators for different frequencies.Design and analysis of FET and MOSFET amplifiers. ■			
Question paper pattern: <ul style="list-style-type: none">The question paper will have ten questions.Each full question is for 20 marks.There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.Each full question with sub questions will cover the contents under a module.Students will have to answer 5 full questions, selecting one full question from each module. ■			
Text Books			
1	Electronic Devices and Circuit Theory	Robert L Boylestad Louis Nashelsky	Pearson 11th Edition, 2015
2	Electronic Devices and Circuits	Millman and Halkias	Mc Graw Hill 4th Edition, 2015
3	Electronic Devices and Circuits	David A Bell	Oxford University Press 5th Edition, 2008
Reference Books			
1	Microelectronics Circuits Analysis and Design	Muhammad Rashid	Cengage Learning 2 nd Edition, 2014

2	A Text Book of Electrical Technology, Electronic Devices and Circuits	B.L. Theraja, A.K. Theraja,	S. Chand	Reprint, 2013
3	Electronic Devices and Circuits	Anil K. Maini Vasha Agarval	Wiley	1st Edition, 2009
4	Electronic Devices and Circuits	S.Salivahanan N.Suresh	Mc Graw Hill	3rd Edition, 2013
5	Fundamentals of Analog Circuits	Thomas L Floyd	Pearson	2nd Edition, 2012

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - III			
DIGITAL SYSTEM DESIGN			
Subject Code	18EE35	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> • Illustrate simplification of Algebraic equations using Karnaugh Maps and Quine- McClusky Techniques. • Design combinational logic circuits. • Design Decoders, Encoders, Digital Multiplexer, Adders, Subtractors and Binary Comparators • Describe Latches and Flip-flops, Registers and Counters. • Analyze Mealy and Moore Models. • Develop state diagrams, Synchronous Sequential Circuits and to understand the basics of various Memories. ■ 			
Module-1			
Principles of Combinational Logic: Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, Incompletely specified functions (Don't care terms) Simplifying Max term equations, Quine-McCluskey minimization technique, Quine-McCluskey using don't care terms, Reduced prime implicants Tables. ■			
Module-2			
Analysis and Design of Combinational logic: General approach to combinational logic design, Decoders, BCD decoders, Encoders, digital multiplexers, Using multiplexers as Boolean function generators, Adders and subtractors, Cascading full adders, Look ahead carry, Binary comparators. ■			
Module-3			
Flip-Flops: Basic Bistable elements, Latches, Timing considerations, The master-slave flip-flops (pulse-triggered flip-flops): SR flip-flops, JK flip-flops, Edge triggered flip-flops, Characteristic equations. ■			
Module – 4			
Flip-Flops Applications: Registers, binary ripple counters, synchronous binary counters, Counters based on shift registers, Design of a synchronous counter, Design of a synchronous mod-n counter using clocked T, JK, D and SR flip-flops. ■			
Module – 5			
Sequential Circuit Design: Mealy and Moore models, State machine notation, Synchronous Sequential circuit analysis, Construction of state diagrams, counter design. Memories: Read only and Read/Write Memories, Programmable ROM, EPROM, Flash memory. ■			
Course Outcomes: After studying this course, students will be able to: <ul style="list-style-type: none"> • Develop simplified switching equation using Karnaugh Maps and QuineMcClusky techniques. • Design Multiplexer, Encoder, Decoder, Adder, Subtractors and Comparator as digital combinational control circuits. • Design flip flops, counters, shift registers as sequential control circuits. • Develop Mealy/Moore Models and state diagrams for the given clocked sequential circuits. • Explain the functioning of Read only and Read/Write Memories, Programmable ROM, EPROM and Flash memory. ■ 			
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question is for 20 marks. • There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. • Each full question with sub questions will cover the contents under a module. • Students will have to answer 5 full questions, selecting one full question from each module. ■ 			
Text Books			

1	Digital Logic Applications and Design,	John M Yarbrough,	Thomson Learning	2001 ISBN 981-240-062-1.
2	Digital Principles and Design	Donald D. Givone	McGraw Hill	2002 ISBN 978-0-07-052906-9.
Reference Books				
1	Digital Circuits and Design	D. P. Kothari and J. S Dhillon	Pearson	2016, ISBN:9789332543539
2	Digital Design	Morris Mano	Prentice Hall of India	Third Edition
3	Fundamentals of logic design	Charles H Roth, Jr.,	Cengage Learning.	Fifth Edition

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - III			
ELECTRICAL MACHINES LABORATORY - 1			
Subject Code	18EEL37	CIE Marks	40
Number of Practical Hours/Week	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> • Conducting of different tests on transformers and synchronous machines and evaluation of their performance. • Verify the parallel operation of two single phase transformers. • Study the connection of single phase transformers for three phase operation and phase conversion. • Study of synchronous generator connected to infinite bus. 			
Sl. No.	Experiments		
1	Open Circuit and Short circuit tests on single phase step up or step down transformer and pre-determination of (i) Efficiency and regulation (ii) Calculation of parameters of equivalent circuit.		
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency.		
3	Parallel operation of two dissimilar single-phase transformers of different kVA and determination of load		
4	Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency and regulation under balanced resistive load.		
5	Comparison of performance of 3 single-phase transformers in delta – delta and V – V (open delta) connection under load.		
6	Scott connection with balanced and unbalanced loads.		
7	Separation of hysteresis and eddy current losses in single phase transformer.		
8	Voltage regulation of an alternator by EMF and MMF methods.		
9	Voltage regulation of an alternator by ZPF method.		
10	Power angle curve of synchronous generator or Direct load test on three phase synchronous generator to determine efficiency and regulation		
11	Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.		
12	Performance of synchronous generator connected to infinite bus, under constant power and variable excitation & vice - versa.		

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

- Evaluate the performance of transformers from the test data obtained.
- Connect and operate two single phase transformers of different KVA rating in parallel.
- Connect single phase transformers for three phase operation and phase conversion.
- Compute the voltage regulation of synchronous generator using the test data obtained in the laboratory.
- Evaluate the performance of synchronous generators from the test data and assess the performance of synchronous generator connected to infinite bus.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - III			
ELECTRONICS LABORATORY			
Subject Code	18EEL38	CIE Marks	40
Number of Practical Hours/Week	0:2:0	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none">To design and test half wave and full wave rectifier circuits.To design and test different amplifier and oscillator circuits using BJT.To study the simplification of Boolean expressions using logic gates.To realize different Adders and Subtractors circuits.To design and test counters and sequence generators. ■			
Sl. No	Experiments		
1	Design and Testing of Full wave – centre tapped transformer type and Bridge type rectifier circuits with and without Capacitor filter. Determination of ripple factor, regulation and efficiency.		
2	Static Transistor characteristics for CE, CB and CC modes and determination of h parameters.		
3	Frequency response of single stage BJT and FET RC coupled amplifier and determination of half power points, bandwidth, input and output impedances.		
4	Design and testing of BJT -RC phase shift oscillator for given frequency of oscillation.		
5	Determination of gain, input and output impedance of BJT Darlington emitter follower with and without bootstrapping.		
6	Simplification, realization of Boolean expressions using logic gates/Universal gates.		
7	Realization of Half/Full adder and Half/Full Subtractors using logic gates.		
8	Realization of parallel adder/Subtractors using 7483 chip- BCD to Excess-3 code conversion and Vice - Versa.		
9	Realization of Binary to Gray code conversion and vice versa.		
10	Design and testing Ring counter/Johnson counter.		
11	Design and testing of Sequence generator.		
12	Realization of 3 bit counters as a sequential circuit and MOD – N counter design using 7476, 7490, 74192,		
*Note: A minimum of three experiments to be simulated using (Freeware Software Package)			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">Design and test rectifier circuits with and without capacitor filters.Determine h-parameter models of transistor for all modes.Design and test BJT and FET amplifier and oscillator circuits.Realize Boolean expressions, adders and subtractors using gates.Design and test Ring counter/Johnson counter, Sequence generator and 3 bit counters. ■			
Conduct of Practical Examination: <ol style="list-style-type: none">All laboratory experiments are to be included for practical examination.Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.Students can pick one experiment from the questions lot prepared by the examiners.Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero ■			

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - IV			
ELECTRIC MOTORS			
Course Code	18EE44	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To study the constructional features of Motors and select a suitable drive for specific application. To study the constructional features of Three Phase and Single phase induction Motors. To study different test to be conducted for the assessment of the performance characteristics of motors. To study the speed control of motor by a different methods. Explain the construction and operation of Synchronous motor and special motors. ■ 			
Module-1			
DC Motors: Classification, Back emf, Torque equation, and significance of back emf, Characteristics of shunt, series & compound motors. Speed control of shunt, series and compound motors. Application of motors. DC motor starters – 3 point and 4 point. Losses and Efficiency- Losses in DC motors, power flow diagram, efficiency, condition for maximum efficiency. ■			
Module-2			
Testing of DC Motors: Direct & indirect methods of testing of DC motors-Brake test, Swinburne's test, Retardation test, Hopkinson's test, Field's test, merits and demerits of tests. Three Phase Induction Motors: Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring (No question shall be set from the review portion). Slip, Torque equation, torque-slip characteristic covering motoring, generating and braking regions of operation, Maximum torque, significance of slip. ■			
Module-3			
Performance of Three-Phase Induction Motor: Phasor diagram of induction motor on no-load and on load, equivalent circuit, losses, efficiency, No-load and blocked rotor tests. Performance of the motor from the circle diagram and equivalent circuit. Cogging and crawling. High torque rotors-double cage and deep rotor bars. Equivalent circuit and performance evaluation of double cage induction motor. Induction motor working as induction generator. ■			
Module-4			
Starting and Speed Control of Three-Phase Induction Motors: Need for starter. Direct on line, Star-Delta and autotransformer starting. Rotor resistance starting. Speed control by voltage, frequency, and rotor resistance methods Single-Phase Induction Motor: Double revolving field theory and principle of operation. Construction and operation of split-phase, capacitor start, capacitor run, and shaded pole motors. Comparison of single phase motors and applications. ■			
Module-5			
Synchronous Motor: Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, V and inverted V curves. Synchronous condenser, hunting and damping. Methods of starting synchronous motors. Other Motors: Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motors. ■			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Explain the construction, operation and classification of DC Motor, AC motor and Special purpose motors. Describe the performance characteristics & applications of Electric motors. Demonstrate and explain the methods of testing of DC machines and determine losses and efficiency. Control the speed of DC motor and induction motor. Explain the starting methods, equivalent circuit and phasor diagrams, torque angle, effect of change in excitation and change in load, hunting and damping of synchronous motors. ■ 			

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Books:

1	Electric Machines	D. P. Kothari, I. J. Nagrath	McGraw Hill	4th edition, 2011
2	Theory of Alternating Current Machines	Alexander Langsdorf	McGraw Hill	2nd Edition, 2001
3	Electric Machines	Ashfaq Hussain	Dhanpat Rai & Co	2nd Edition, 2013

Reference Books:

1	Electrical Machines, Drives and Power systems	Theodore Wildi	Pearson	6th Edition, 2014
2	Electrical Machines	M.V. Deshpande	PHI Learning	2013
3	Electric Machinery and Transformers	Bhag S Guru at el	Oxford University Press	3 rd Edition, 2012
4	Electric Machinery and Transformers	Irving Kosow	Pearson	2nd Edition, 2012
5	Principles of Electric Machines and	P.C.Sen	Wiley	2nd Edition, 2013
6	Electric Machines	R.K. Srivastava	Cengage Learning	2nd Edition, 2013

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - IV			
ELECTROMAGNETIC FIELD THEORY			
Course Code	18EE45	CIE Marks	40
Number of Lecture Hours/Week	2:2:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector. To study the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations. To evaluate the energy and potential due to a system of charges. To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics. To study the magnetic fields and magnetic materials. To study the time varying fields and propagation of waves in different media. ■ 			
Module-1			
Vector Analysis: Scalars and Vectors, Vector algebra, Cartesian co-ordinate system, Vector Components and unit vectors. Scalar field and Vector field. Dot product and Cross product, Gradient of a scalar field. Divergence and Curl of a vector field. Co – ordinate systems: cylindrical and spherical, relation between different coordinate systems. Expression for gradient, divergence and curl in rectangular, cylindrical and spherical co-ordinate systems. Numerical. Electrostatics: Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics). Divergence theorem. Numerical. ■			
Module-2			
Energy and Potential: Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. The dipole. Energy density in the electrostatic field. Numerical. Conductor and Dielectrics: Current and current density. Continuity of current. Metallic conductors, conductor's properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Numerical. ■			
Module-3			
Poisson's and Laplace Equations: Derivations and problems, Uniqueness theorem. Steady magnetic fields: Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Numerical.■			
Module-4			
Magnetic forces: Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Numerical. Magnetic Materials and Magnetism: Nature of magnetic materials, magnetisation and permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Numerical. ■			
Module-5			
Time Varying Fields and Maxwell's Equations: Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Numerical. Uniform plane wave: Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Numerical.■			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Use different coordinate systems , Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations. Calculate the energy and potential due to a system of charges & Explain the behavior of electric field across a boundary conditions. Explain the Poisson's, Laplace equations and behavior of steady magnetic fields. Explain the behavior of magnetic fields and magnetic materials. Asses time varying fields and propagation of waves in different media. ■ 			

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Books:

1	Engineering Electromagnetics	William H Hayt et al	McGraw Hill	8 th Edition, 2014
2	Principles of Electromagnetics	Matthew N. O. Sadiku	Oxford	6 th Edition, 2015

Reference Books:

1	Fundamentals of Engineering Electromagnetics	David K. Cheng	Pearson	2014
2	Electromagnetism -Theory (Volume -1) -Applications (Volume-2)	Ashutosh Pramanik	PHI Learning	2014
3	Electromagnetic Field Theory Fundamentals	Bhag Guru et al	Cambridge	2005
4	Electromagnetic Field Theory	Rohit Khurana	Vikas Publishing	1 st Edition, 2014
5	Electromagnetics	J. A. Edminister	McGraw Hill	3 rd Edition, 2010
6	Electromagnetic Field Theory and Transmission Lines	Gottapu Sasibhushana Rao	Wiley	1st Edition, 2013

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING				
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)				
SEMESTER - IV				
OPERATIONAL AMPLIFIERS AND LINEAR ICs				
Course Code	18EE46	CIE Marks	40	
Number of Lecture Hours/Week	3:0:0	SEE Marks	60	
Credits	03	Exam Hours	03	
Course Learning Objectives: <ul style="list-style-type: none">• To understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.• To learn the designing of various circuits using linear ICs.• To use these linear ICs for specific applications.• To understand the concept and various types of converters.• To use these ICs, in Hardware projects.				
Module-1				
Operational Amplifiers: Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback(excluding derivations).				
General Linear Applications: A.C. amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, Instrumentation amplifier. ■ T1				
Module-2				
Active Filters: First & Second order high pass & low pass Butterworth filters. Band pass filters, all pass filters.				
DC Voltage Regulators: voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators. ■ T1				
Module-3				
Signal Generators: Triangular / rectangular wave generator, phase shift oscillator, saw tooth oscillator.				
Comparators & Converters: Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters. ■ T1				
Module-4				
Signal processing circuits: Precision half wave & full wave rectifiers				
A/D & D/A Converters: Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC ■ R1				
Module-5				
Phase Locked Loop (PLL): Basic PLL, components, performance factors.				
Timer: Internal architecture of 555 timer, Mono stable multivibrators and applications. ■ T1				
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">• Describe the characteristics of ideal and practical operational amplifier.• Design filters and signal generators using linear ICs.• Demonstrate the application of Linear ICs as comparators and rectifiers.• Analyze voltage regulators for given specification using op-amp and IC voltage regulators.• Summarize the basics of PLL and Timer. ■				
Question paper pattern: <ul style="list-style-type: none">• The question paper will have ten questions.• Each full question is for 20 marks.• There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.• Each full question with sub questions will cover the contents under a module.• Students will have to answer 5 full questions, selecting one full question from each module. ■				
Text Books:				
1	Op-Amps and Linear Integrated Circuits	Ramakant A Gayakwad	Pearson	4 th Edition 2015
Reference Books:				

1	Operational Amplifiers and Linear ICs	David A. Bell	Oxford	3 rd Edition 2011
2	Linear Integrated Circuits; Analysis, Design and	B. Somanthan Nair	Wiley India	2013
3	Linear Integrated Circuits	S. Salivahanan, et al	McGraw Hill	2 nd Edition, 2014
4	Operational Amplifiers and Linear Integrated Circuits	K. Lal Kishore	Pearson	1 st Edition, 2012

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - IV			
ELECTRICAL MACHINES LABORATORY - 2			
Course Code	18EEL47	CIE Marks	40
Number of Practical Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none">• To perform tests on DC machines to determine their characteristics.• To control the speed of DC motor.• To conduct test for pre-determination of the performance characteristics of DC machines• To conduct load test on single phase and three phase induction motor.• To conduct test on induction motor to determine the performance characteristics.• To conduct test on synchronous motor to draw the performance curves. ■			
S No.	Experi		
1	Load test on DC shunt motor to draw speed–torque and horse power–efficiency characteristics.		
2	Field Test on DC series machines.		
3	Speed control of DC shunt motor by armature and field control.		
4	Swin burne's Test on DC motor.		
5	Retardation test on DC shunt motor.		
6	Regenerative test on DC shunt machines.		
7	Load test on three phase induction motor.		
8	No-load and Blocked rotor test on three phase induction motor to draw(i)equivalent circuit and(ii)circle diagram. Determination of performance parameters at different load conditions		
9	Load test on induction generator.		
10	Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.		
11	Conduct suitable tests to draw thee equivalent circuit of single phase induction motor and determine performance parameters.		
12	Conduct an experiment to draw v and Inverted curves of synchronous motor at no load and load conditions.		
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">• Test DC machines to determine their characteristics and also to control the speed of DC motor.• Pre-determine the performance characteristics of DC machines by conducting suitable tests.• Perform load test on single phase and three phase induction motor to assess its performance.• Conduct test on induction motor to pre-determine the performance characteristics.• Conduct test on synchronous motor to draw the performance curves. ■			
Conduct of Practical Examination: <ol style="list-style-type: none">1. All laboratory experiments are to be included for practical examination.2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.3. Students can pick one experiment from the questions lot prepared by the examiners.4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made			

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - V			
MICROCONTROLLER			
Course Code	18EE52	CIE Marks	40
Number of Lecture Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To explain the internal organization and working of Computers, microcontrollers and embedded processors. Compare and contrast the various members of the 8051 family. To explain the registers of the 8051 microcontroller, manipulation of data using registers and MOV instructions. To explain in detail the execution of 8051 Assembly language instructions and data types To explain loop, conditional and unconditional jump and call, handling and manipulation of I/O instructions. To explain different addressing modes of 8051, arithmetic, logic instructions, and programs. To explain develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic, 			
Module-1			
8051 Microcontroller Basics: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM. 8051 Addressing Modes. ■			
Module-2			
Assembly Programming and Instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. ■			
Module-3			
8051 Programming in C: Data types and time delay in 8051C, IO programming in 8051C, Logic operations in 8051 C, Data conversion program in 8051 C, Accessing code ROM space in 8051C, Data serialization using 8051C 8051 Timer Programming in Assembly and C: Programming 8051 timers, Counter programming, Programming timers 0 and 1 in 8051 C. ■			
Module-4			
8051 Serial Port Programming in Assembly and C: Basics of serial communication, 8051 connection to RS232, 8051 serial port programming in assembly, serial port programming in 8051 C. 8051 Interrupt Programming in Assembly and C: 8051 interrupts, Programming timer, external hardware, serial communication interrupt, Interrupt priority in 8051/52, Interrupt programming in C. ■			
Module-5			
Interfacing: LCD interfacing, Keyboard interfacing. ADC, DAC and Sensor Interfacing: ADC 0808 interfacing to 8051, Serial ADC Max1112 ADC interfacing to 8051, DAC interfacing, Sensor interfacing and signal conditioning. Motor Control: Relay, PWM, DC and Stepper Motor: Relays and opt isolators, stepper motor interfacing, DC motor interfacing and PWM. 8051 Interfacing with 8255: Programming the 8255, 8255 interfacing, C programming for 8255. ■			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Outline the 8051 architecture, registers, internal memory organization, addressing modes. Discuss 8051 addressing modes, instruction set of 8051, accessing data and I/O port programming. Develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic and arithmetic operations, data conversion and timer/counter programming. Summarize the basics of serial communication and interrupts, also develop 8051 programs for serial data communication and interrupt programming. Program 8051 to work with external devices for ADC, DAC, Stepper motor control, DC motor control, Elevator control. ■ 			

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	The 8051 Microcontroller and Embedded Systems Using Assembly and C	Muhammad Ali Mazadi	Pearson	2 nd Edition, 2008.
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Reference Books

1	The 8051 Microcontroller	Kenneth Ayala	Cengage Learning	3 rd Edition, 2005
2	The 8051 Microcontroller and Embedded Systems	Manish K Patel	McGraw Hill	2014
3	Microcontrollers: Architecture, Programming, Interfacing and System Design	Raj Kamal	Pearson	1 st Edition, 2012

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

POWER ELECTRONICS

Course Code	18EE53	CIE Marks	40
Number of Lecture Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics.
- To explain power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and limitations.
- To explain different types of Thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers.

Module-1

Introduction: Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switches.

Power Diodes: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes, Freewheeling diodes with RL load.

Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase Full-Wave Rectifiers with R load, Single-Phase Full-Wave Rectifier with RL Load. ■ **T1 & R1**

Module-2

Power Transistors: Introduction, Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction Transistors – Steady State Characteristics, Switching Characteristics, Switching Limits, IGBTs, MOSFET Gate Drive, BJT Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers. ■ **T1**

Module-3

Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn-On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dt Protection, dv/dt Protection, DIACs, Thyristor Firing Circuits, Unijunction Transistor. ■ **T1**

Module-4

Controlled Rectifiers: Introduction, Single phase half wave circuit with RL Load, Single phase half wave circuit with RL Load and Freewheeling Diode, Single phase half wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual Converters, Principle of operation of Three- Phase dual Converters.

AC Voltage Controllers: Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers. ■ **T1 & R1**

Module-5

DC-DC Converters: Introduction, principle of step down and step up chopper with RL load, performance parameters, DC-DC converter classification.

DC-AC Converters: Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters. ■ **T1**

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

- To give an overview of applications power electronics, different types of power semiconductor devices, their switching characteristics, power diode characteristics, types, their operation and the effects of power diodes on RL circuits.
- To explain the techniques for design and analysis of single phase diode rectifier circuits.
- To explain different power transistors, their steady state and switching characteristics and limitations.
- To explain different types of Thyristors, their gate characteristics and gate control requirements.
- To explain the design, analysis techniques, performance parameters and characteristics of controlled rectifiers, DC- DC, DC -AC converters and Voltage controllers. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	Power Electronics: Circuits Devices and Applications	Mohammad H Rashid,	Pearson	4th Edition, 2014
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Reference Books

1	Power Electronics	P.S. Bimbhra	Khanna Publishers	5th Edition, 2012
2	Power Electronics: Converters, Applications	Ned Mohan et al	Wiley	3rd Edition, 2014
3	Power Electronics	Daniel W Hart	McGraw Hill	1 st Edition, 2011
4	Elements of Power Electronics	Philip T Krein	Oxford	Indian Edition, 2008

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - V			
MICROCONTROLLER LABORATORY			
Course Code	18EEL57	CIE Marks	40
Number of Practical Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	3
Course Learning Objectives: <ul style="list-style-type: none">To explain writing assembly language programs for data transfer, arithmetic, Boolean and logical instructions.To explain writing assembly language programs for code conversions.To explain writing assembly language programs using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.To perform interfacing of stepper motor and DC motor for controlling the speed.To explain generation of different waveforms using DAC interface. ■			
Sl. No.	Experiments		
Note: For the experiments 1 to 6, 8051 assembly programming is to be used.			
1	Data transfer – Program for block data movement, sorting, exchanging, finding largest element in an array.		
2	Arithmetic instructions: Addition, subtraction, multiplication and division. Square and cube operations for		
3	Counters		
4	Boolean and logical instructions (bit manipulation).		
5	Conditional call and return instructions.		
6	Code conversion programs – BCD to ASCII, ASCII to BCD, ASCII to decimal, Decimal to ASCII, Hexa		
7	Programs to generate delay, Programs using serial port and on-chip timer/counters.		
Note: Single chip solution for interfacing 8051 is to be with C Programs for the following experiments.			
8	Stepper motor interface.		
9	DC motor interface for direction and speed control using PWM.		
10	Alphanumeric LCD panel interface.		
11	Generate different waveforms: Sine, Square, Triangular, Ramp using DAC interface.		
12	External ADC and Temperature control interface.		
13	Elevator interface.		
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">Write assembly language programs for data transfer, arithmetic, Boolean and logical instructions and code conversions.Write ALP using subroutines for generation of delays, counters, configuration of SFRs for serial communication and timers.Perform interfacing of stepper motor and dc motor for controlling the speed, elevator, LCD, external ADC and temperature control.Generate different waveforms using DAC interface.Work with a small team to carryout experiments using microcontroller concepts and prepare reports that present lab work.■			
Conduct of Practical Examination: <ol style="list-style-type: none">All laboratory experiments are to be included for practical examination.Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.Students can pick one experiment from the questions lot prepared by the examiners.Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.			

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - V			
POWER ELECTRONICS LABORATORY			
Course Code	18EEL58	CIE Marks	40
Number of Practical Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none">To conduct experiments on semiconductor devices to obtain their static characteristics.To study different methods of triggering the SCRTo study the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.To control the speed of a DC motor, universal motor and stepper motors.To study single phase full bridge inverter connected to resistive load. ■			
Sl. No	Experiments		
1	Static Characteristics of SCR.		
2	Static Characteristics of MOSFET and IGBT.		
3	Characteristic of TRIAC.		
4	SCR turn on circuit using synchronized UJT relaxation oscillator.		
5	SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.		
6	Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without free wheeling diode		
7	AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.		
8	Speed control of DC motor using single semi converter.		
9	Speed control of stepper motor.		
10	Speed control of universal motor using ac voltage regulator.		
11	Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.		
12	Single phase MOSFET/IGBT based PWM inverter.		
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">Obtain static characteristics of semiconductor devices to discuss their performance.Trigger the SCR by different methodsVerify the performance of single phase controlled full wave rectifier and AC voltage controller with R and RL loads.Control the speed of a DC motor, universal motor and stepper motors.Verify the performance of single phase full bridge inverter connected to resistive load. ■			
Conduct of Practical Examination: <ol style="list-style-type: none">All laboratory experiments are to be included for practical examination.Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.Students can pick one experiment from the questions lot prepared by the examiners.Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■			

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
CONTROL SYSTEMS (Core Subject)			
Course Code	18EE61	CIE Marks	40
Number of Lecture Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> • To define a control system • To explain the necessity of feedback and types of feedback control systems. • To introduce the concept of transfer function and its application the modeling of linear systems. • To demonstrate mathematical modeling of control systems. • To obtain transfer function of systems through block diagram manipulation and reduction • To use Mason's gain formula for finding transfer function of a system • To discuss transient and steady state time response of a simple control system. • To discuss the stability of linear time invariant systems and Routh-Hurwitz criterion • To investigate the trajectories of the roots of the characteristic equation when a system parameter is varied. • To conduct the control system analysis in the frequency domain. • To discuss stability analysis using Bode plots. • To determine the controller or compensator configuration and parameter values relative to how it is 			
Module-1			
Introduction to Control Systems: Introduction, classification of control systems. Mathematical models of physical systems: Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains.			
Module-2			
Block Diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function. Signal Flow Graphs: Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.			
Module-3			
Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems. Routh Stability Criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.			
Module-4			
Root locus Technique: Introduction, root locus concepts, construction of root loci, rules for the construction of root locus. Frequency Response Analysis: Co-relation between time and frequency response – 2nd order systems only. Bode Plots: Basic factors $G(j\omega)/H(j\omega)$, General procedure for constructing bode plots, computation of gain margin and phase margin.			
Module-5			
Nyquist plot: Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion. Design of Control Systems: Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller.			

Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Analyze and model electrical and mechanical system using analogous. Formulate transfer functions using block diagram and signal flow graphs. Analyze the stability of control system, ability to determine transient and steady state time response. Illustrate the performance of a given system in time and frequency domains, stability analysis using Root locus and Bode plots. Discuss stability analysis using Nyquist plots, Design controller and compensator for a given specification. ■ 				
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question is for 20 marks. There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. Each full question with sub questions will cover the contents under a module. Students will have to answer 5 full questions, selecting one full question from each module. ■ 				
Text Book				
1	Control Systems	Anand Kumar	PHI	2 nd Edition, 2014
Reference Books				
1	Automatic Control Systems	Farid Golnaraghi, Benjamin C. Kuo	Wiley	9 th Edition, 2010
2	Control System Engineering	Norman S. Nise	Wiley	4 th Edition, 2004
3	Modern Control Systems	Richard C Dorf et al	Pearson	11 th Edition, 2008
4	Control Systems, Principles and	M. Gopal	McGraw Hill	4 th Edition, 2012
5	Control Systems Engineering	S. Salivahan et al	Pearson	1 st Edition, 2015

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
POWER SYSTEM ANALYSIS – 1 (Core Subject)			
Course Code	18EE62	CIE Marks	4
Number of Lecture Hours/Week (L:T:P)	3:2:0	SEE Marks	6
Credits	04	Exam Hours	0
Course Learning Objectives: <ul style="list-style-type: none"> To introduce the per unit system and explain its advantages and computation. To explain the concept of one line diagram and its implementation in problems. To explain the necessity and conduction of short circuit analysis. To explain analysis of three phase symmetrical faults on synchronous machine and simple power systems. To discuss selection of circuit breaker. To explain symmetrical components, their advantages and the calculation of symmetrical components of voltages and currents in un-balanced three phase circuits. To explain the concept of sequence impedance and its analysis in three phase unbalanced circuits. To explain the concept of sequence networks and sequence impedances of an unloaded synchronous generator, transformers and transmission lines. To explain the analysis of synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components. To discuss the dynamics of synchronous machine and derive the power angle equation for a synchronous machine. Discuss stability and types of stability for a power system and the equal area criterion for the evaluation of stability of a simple system. ■ 			
Module-1			
Representation of Power System Components: Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU) System, Steady State Model of Synchronous Machine, Power Transformer, Transmission of Electrical Power, Representation of Loads. ■			
Module-2			
Symmetrical Fault Analysis: Introduction, Transient on a Transmission Line, Short Circuit of a Synchronous Machine(On No Load), Short Circuit of a Loaded Synchronous Machine, Illustrative simple examples on power systems. Selection of Circuit Breakers. ■			
Module-3			
Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances of Transmission Lines, Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines, Sequence Impedances and Networks of Transformers, Construction of Sequence Networks of a Power System. ■			
Module-4			
Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults. ■			

Module-5				
Power System Stability: Introduction, Dynamics of a Synchronous Machine, Review of Power Angle Equation, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability, Multi machine stability studies, classical representation. ■				
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> • Model the power system components & construct per unit impedance diagram of power system. • Analyze three phase symmetrical faults on power system. • Compute unbalanced phasors in terms of sequence components and vice versa, also develop sequence networks. • Analyze various unsymmetrical faults on power system. • Examine dynamics of synchronous machine and determine the power system stability. ■ 				
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question is for 20 marks. • There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. • Each full question with sub questions will cover the contents under a module. • Students will have to answer 5 full questions, selecting one full question from each module. ■ 				
Text Book				
1.	Elements of Power System	William D. Stevenson Jr	McGraw Hill	4 th Edition, 1982
Reference Books				
1	Modern Power System	D. P. Kothari	McGraw Hill	4 th Edition, 2011
2	Power System Analysis and Design	J.Duncan Glover et al	Cengage	4 th Edition, 2008
3	Power System Analysis	Hadi Sadat	McGraw Hill	1 st Edition, 2002

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
COMPUTER AIDED ELECTRICAL DRAWING (PROFESSIONAL)			
Course Code	18EE643	CIE Marks	40
Number of Lecture Hours/Week(L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To discuss the terminology of DC and AC armature windings. To discuss design and procedure to draw armature winding diagrams for DC and AC machines. To discuss the substation equipment, their location in a substation and development of a layout for substation. To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts. To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches. 			
Suitable CAD software can be used for drawings			
PART - A			
Module-1			
Winding Diagrams: <p>(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.</p> <p>(b) Developed Winding Diagrams of A.C. Machines:</p> <p>(c) Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.</p> <p>(d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings.</p>			
Module-2			
Single Line Diagrams: Single Line Diagrams of Generating Stations and Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalised Single, Main and Transfer, Double Bus Double Breaker, Sectionalised Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main), Power Transformers, Circuit Breakers, Isolators, Earthing Switches, Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power- Line Carrier) and Line Trap.			
PART - B			
Module-3			
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Transformers - Sectional Views Of Single And Three Phase Core And Shell Type Transformers.			
Module-4			
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: D.C. Machine - Sectional Views of Yoke with Poles, Armature and Commutator dealt separately.			
Module-5			
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Alternator – Sectional Views of Stator and Rotor dealt separately.			
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Develop armature winding diagram for DC and AC machines Develop a Single Line Diagram of Generating Stations and substation using the standard symbols. Construct sectional views of core and shell types transformers using the design data Construct sectional views of assembled DC and AC machine and their parts using the design data or the sketches 			

Question paper pattern:

- The question paper will have two parts, PART – A and PART – B.
- Each part is for 50 marks.
- Part A is for Modules 1 and 2.
- Questions 1 and 2 of PART - A will be only on DC windings or only on AC windings. Students have to answer any one of them. The marks prescribed is 25.
- Question 3 of PART – A covering module 2 is compulsory. The marks prescribed is 15.
- Part B is for Modules 3, 4 and 5.
- Questions 4 and 5 will cover any two modules of modules 3, 4 and 5. Students have to answer any one of them. The marks prescribed is 40. ■

Reference Books

1	A course in Electrical Machine design	A. K. Sawhney	DhanpatRai	6 th Edition, 2013
2	Electrical Engineering Drawing	K. L. Narang	Satya Prakashan	2014

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VI			
CONTROL SYSTEM LABORATORY			
Course Code	18EEL66	CIE Marks	40
Number of Practical Hours/Week(L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none">To determine the time and frequency domain responses of a given second order system using software package or discrete components.To design and analyze Lead, Lag and Lead – Lag compensators for given specifications.To draw the performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair.To study the DC position & feedback control system and to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.To write a script files to plot root locus, bode plot, to study the stability of the system using a			
Sl. NO	Experiments		
1	Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor		
2	Experiment to draw synchro pair characteristics		
3	Experiment to determine frequency response of a second order system		
4	(a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response.		
5	(a) To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. (b) To determine experimentally the transfer function of the lag compensating network		
6	Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.		
7	To study a second order system and verify the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.		
8	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of adding poles and zeros on time response of second order system. (c) To evaluate the effect of pole location on stability		
9	(a) To simulate a D.C. Position control system and obtain its step response. (b) To verify the effect of input waveform, loop gain and system type on steady state errors. (c) To perform trade-off study for lead compensator. (d) To design PI controller and study its effect on steady state error.		
10	(a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response (b) To study the effect of open loop gain on transient response of closed loop system using root locus.		
11	(a) To study the effect of open loop poles and zeros on root locus contour (b) Comparative study of Bode, Nyquist and root locus with respect to stability.		
Note:			
Sl.	Description	Experiment numbers	
1	Perform experiments using suitable components/equipment's	1 & 2	
2	Perform experiments using suitable components/equipment's and verify the results using standard simulation package	3,4,5,6 and 7	
3	Perform simulation only using standard package	8,9,10 and 11	

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

- Utilize software package and discrete components in assessing the time and frequency domain response of a given second order system.
- Design, analyze and simulate Lead, Lag and Lead – Lag compensators for given specifications.
- Determine the performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair used in control systems.
- Simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
- Develop a script files to plot Root locus, Bode plot and Nyquist plot to study the stability of

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING			
Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER -VI			
DIGITAL SIGNAL PROCESSING LABORATORY			
Course Code	18EEL67	CIE Marks	40
Number of Practical Hours/Week(L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives:			
<ul style="list-style-type: none">To explain the use of MATLAB/Scilab/Python software in evaluating the DFT and IDFT of given sequenceTo verify the convolution property of the DFTTo design and implementation of IIR and FIR filters for given frequency specifications.To realize IIR and FIR filters.To help the students in developing software skills. ■			
Sl. No	Experiments		
1	Verification of Sampling Theorem both in time and frequency domains		
2	Evaluation of impulse response of a system		
3	To perform linear convolution of given sequences		
4	To perform circular convolution of given sequences using (a) the convolution summation formula (b)		
5	Computation of N – point DFT and to plot the magnitude and phase spectrum.		
6	Linear and circular convolution by DFT and IDFT method.		
7	Solution of a given difference equation.		
8	Calculation of DFT and IDFT by FFT		
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters)		
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions		
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.		
12	Realization of IIR and FIR filters		
Course Outcomes:			
At the end of the course the student will be able to:			
<ul style="list-style-type: none">Explain physical interpretation of sampling theorem in time and frequency domains.Evaluate the impulse response of a system.Perform convolution of given sequences to evaluate the response of a system.Compute DFT and IDFT of a given sequence using the basic definition and/or fast methods.Provide a solution for a given difference equation.Design and implement IIR and FIR filters. ■			
Conduct of Practical Examination:			
1. All laboratory experiments are to be included for practical examination.			
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.			
3. Students can pick one experiment from the questions lot prepared by the examiners.			
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■			

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII			
POWER SYSTEM ANALYSIS – 2(Core Course)			
Course Code	17EE71	CIE Marks	40
Number of Lecture Hours/Week	2:2:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To explain formulation of network models and bus admittance matrix for solving load flow problems. To discuss optimal operation of generators on a bus bar and optimum generation scheduling. To explain symmetrical fault analysis and algorithm for short circuit studies. To explain formulation of bus impedance matrix for the use in short circuit studies on power systems. To explain numerical solution of swing equation for multi-machine stability 			
Module-1			
Network Topology: Introduction and basic definitions of Elementary graph theory Tree, cut-set, loop analysis. Formation of Incidence Matrices. Primitive network- Impedance form and admittance form, Formation of Y Bus by Singular Transformation. Y_{bus} by Inspection Method. Illustrative examples. T1,2			
Module-2			
Load Flow Studies: Introduction, Classification of buses. Power flow equation, Operating Constraints, Data for Load flow, Gauss Seidal iterative method. Illustrative examples. T1, R1			
Module-3			
Load Flow Studies(continued) Newton-Raphson method derivation in Polar form, Fast decoupled load flow method, Flow charts of LFS methods. Comparison of Load Flow Methods. Illustrative examples. T1, R1			
Module-4			
Economic Operation of Power System: Introduction and Performance curves Economic generation scheduling neglecting losses and generator limits Economic generation scheduling including generator limits and neglecting losses Economic dispatch including transmission losses Derivation of transmission loss formula. Illustrative examples. T1			
Unit Commitment: Introduction, Constraints and unit commitment solution by prior list method and dynamic forward DP approach (Flow chart and Algorithm only). T3			

Module-5				
Symmetrical Fault Analysis: Z Bus Formulation by Step by step building algorithm without mutual coupling between the elements by addition of link and addition of branch. Illustrative examples.Z bus Algorithm for Short Circuit Studies excluding numerical.T1 Power System Stability: Numerical Solution of Swing Equation by Point by Point method and Runge Kutta Method. Illustrative examples. ■ T1				
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Formulate network matrices and models for solving load flow problems. Perform steady state power flow analysis of power systems using numerical iterative techniques. Solve issues of economic load dispatch and unit commitment problems. Analyze short circuit faults in power system networks using bus impedance matrix. Apply Point by Point method and Runge Kutta Method to solve Swing Equation. ■ 				
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question is for 20 marks. There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. Each full question with sub questions will cover the contents under a module. Students will have to answer 5 full questions, selecting one full question from each module. ■ Module 1 Y_{Bus} Matrix size limited to 3X3 for illustrative examples. Module 2 NR Method limited to 3 bus system with one iteration for illustrative examples. 				
Text Books				
1	Modern Power System Analysis	D P Kothari, I J Nagrath	McGraw Hill	4 th Edition, 2011
2	Computer Methods in Power Systems Analysis	Glenn W. Stagg Ahmed H Ei - Abiad	Scientific International Pvt. Ltd.	1 st Edition, 2019
3	Power Generation Operation and Control	Allen J Wood et al	Wiley	2 nd Edition, 2016
Reference Books				
1	Computer Techniques in Power System Analysis	M.A. Pai	McGraw Hill	2 nd Edition, 2012
2	Power System Analysis	Hadi Saadat	McGraw Hill	2nd Edition, 2002

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII			
POWER SYSTEM PROTECTION (Core Subject)			
Course Code	17EE72	CIE Marks	40
Number of Lecture Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To discuss performance of protective relays, components of protection scheme and relay terminology. To explain relay construction and operating principles. To explain Over current protection using electromagnetic and static relays and Over current protective schemes. To discuss types of electromagnetic and static distance relays, effect of arc resistance, power swings, line length and source impedance on performance of distance relays. To discuss pilot protection; wire pilot relaying and carrier pilot relaying. To discuss construction, operating principles and performance of various differential relays for differential protection. To discuss protection of generators, motors, Transformer and Bus Zone Protection. To explain the principle of circuit interruption and different types of circuit breakers. To describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse. To discuss protection Against Over voltages and Gas Insulated Substation (GIS). ■ 			
Module-1			
Introduction to Power System Protection: Need for protective schemes, Nature and Cause of Faults, Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection. Relay Construction and Operating Principles: Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays. Overcurrent Protection: Introduction, Time – current Characteristics, Current Setting, Time Setting. ■			
Module-2			
Overcurrent Protection (continued): Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays. Distance Protection: Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays. ■			
Module-3			
Pilot Relaying Schemes: Introduction, Wire Pilot Protection, Carrier Current Protection Differential Protection: Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection. Rotating Machines Protection: Introduction, Protection of Generators. Transformer and Buszone Protection: Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection. ■			

Module-4				
Circuit Breakers: Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Restriking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF ₆ Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers. ■				
Module-5				
Fuses: Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination.				
Protection against Overvoltages: Causes of Overvoltages, Lightning phenomena, Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL).				
Modern Trends in Power System Protection: Introduction, gas insulated substation/switchgear (GIS). ■				
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> • Discuss performance of protective relays, components of protection scheme and relay terminology over current protection. • Explain the working of distance relays and the effects of arc resistance, power swings, line length and source impedance on performance of distance relays. • Discuss pilot protection, construction, operating principles and performance of differential relays and discuss protection of generators, motors, transformer and Bus Zone Protection. • Explain the construction and operation of different types of circuit breakers. • Outline features of fuse, causes of overvoltages and its protection, also modern trends in Power System Protection. ■ 				
Question paper pattern: <ul style="list-style-type: none"> • The question paper will have ten questions. • Each full question is for 20 marks. • There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. • Each full question with sub questions will cover the contents under a module. • Students will have to answer 5 full questions, selecting one full question from each module. ■ 				
Text Books				
1	Power System Protection and Switchgear	Badri Ram, D.N. Vishwakarma	McGraw Hill	2 nd Edition
2	Power System Protection and Switchgear	Bhuvanesh Oza et al	McGraw Hill	1 st Edition, 2010
Reference Books				
1	Protection and Switchgear	Bhavesht et al	Oxford	1 st Edition, 2011
2	Power System Switchgear and Protection	N. Veerappan S.R. Krishnamurthy	S. Chand	1 st Edition, 2009
3	Fundamentals of Power System Protection	Y.G.Paithankar S.R. Bhide	PHI	1 st Edition, 2009

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII			
UTILIZATION OF ELECTRICAL POWER(Professional Elective)			
Course Code	17EE742	CIE Marks	40
Number of Lecture Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> • To discuss electric heating, air-conditioning and electric welding. • To explain laws of electrolysis, extraction and refining of metals and electro deposition. • To explain the terminology of illumination, laws of illumination, construction and working of electric lamps. • To explain design of interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting • To discuss systems of electric traction, speed time curves and mechanics of train movement. • To discuss motors used for electric traction and their control. • To discuss braking of electric motors, traction systems and power supply and other traction systems. • Give awareness of technology of electric and hybrid electric vehicles. ■ 			
Module-1			
Heating and welding: Electric Heating, Resistance ovens, Radiant Heating, Induction Heating, High frequency Eddy Current Heating, Dielectric Heating, The Arc Furnace, Heating of Buildings, Air – Conditioning, Electric Welding, Modern Welding Techniques. Electrolytic Electro – Metallurgical Process: Ionization, Faraday’s Laws of Electrolysis, Definitions, Extraction of Metals, Refining of Metals, Electro Deposition. ■			
Module-2			
Illumination: Introduction, Radiant Energy, Definitions, Laws of Illumination, Polar Curves, Photometry, Measurement of Mean Spherical Candle Power by Integrating Sphere, Illumination Photometer, Energy Radiation and luminous Efficiency, electric Lamps, Cold Cathode Lamp, Lighting Fittings, Illumination for Different Purposes, Requirements of Good Lighting. ■			
Module-3			
Electric Traction Speed - Time Curves and Mechanics of Train Movement: Introduction, Systems of Traction, Systems of electric Traction, Speed - Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion. Motors for Electric traction: Introduction, Series and Shunt Motors for Traction Services, Two Similar Motors (Series Type) are used to drive a Motor Car, Tractive Effort and Horse Power, AC Series Motor, Three Phase Induction Motor. Control of motors: Control of DC Motors, Tapped Field Control or Control by Field Weakening, Multiple Unit Control, Control of Single Phase Motors, Control of Three Phase Motors. ■			
Module-4			
Braking: Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes. Electric Traction Systems and Power Supply: System of Electric Traction, AC Electrification Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC Traction Feeding and Distribution System for DC Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires. Trams, Trolley Buses and Diesel – Electric Traction: Tramways, The Trolley – Bus, Diesel Electric Traction. ■			
Module-5			
Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving, Energy Consumption. Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains. ■			

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

- Discuss different methods of electric heating & welding.
- Discuss the laws of electrolysis, extraction, refining of metals and electro deposition process.
- Discuss the laws of illumination, different types of lamps, lighting schemes and design of lighting systems.
- Analyze systems of electric traction, speed time curves and mechanics of train movement.
- Explain the motors used for electric traction, their control & braking and power supply system used for electric traction. ■

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of three sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module. ■

Text Book

1	A Text Book on Power System Engineering	A. Chakrabarti et al	Dhanpat Rai and Co	2 nd Edition, 2010
2	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design (Chapters 04 and 05 for module 5)	Mehrdad Ehsani et al	CRC Press	1 st Edition, 2005

Reference Books

1	Utilization, Generation and Conservation of Electrical Energy	Sunil S Rao	Khanna Publishers	1 st Edition, 2011
2	Utilization of Electric Power and Electric Traction	G.C. Garg	Khanna Publishers	9 th Edition, 2014

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII			
POWER SYSTEM SIMULATION LABORATORY			
Course Code	17EEL76	CIE Marks	40
Number of Practical Hours/Week(L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: To explain the use of standard software package: (Ex: MATLAB/C or C ++/Scilab/ Octave/Python software) <ul style="list-style-type: none">To assess the performance of medium and long transmission lines.To obtain the power angle characteristics of salient and non- salient pole alternator.To study transient stability of radial power systems under three phase fault conditions.To develop admittance and impedance matrices of interconnected power systems.To explain the use of suitable standard software package.To solve power flow problem for simple power systems.To perform fault studies for simple radial power systems.To study optimal generation scheduling problems for thermal power plants. ■			
Sl. No.	Experiments		
1	Use of Standard Simulation Software Package	Formation for symmetric π /T configuration for Verification of Determination of Efficiency and Regulation. ■	
2		Determination of Power Angle Diagrams, Reluctance Power, Excitation, EMF and Regulation for Salient and Non-Salient Pole Synchronous Machines.	
3		To obtain Swing Curve and to Determine Critical Clearing Time, Regulation, Inertia Constant/Line Parameters /Fault Location/Clearing Time/Pre-Fault Electrical Output for a Single Machine connected to Infinite Bus through a Pair of identical Transmission Lines Under 3-Phase Fault On One of the two Lines.	
4		Y Bus Formation for Power Systems with and without Mutual Coupling, by Singular	
5		Formation of Z Bus(without mutual coupling) using Z-Bus Building Algorithm.	
6		Determination of Bus Currents, Bus Power and Line Flow for a Specified System Voltage ■	
7		Formation of Jacobian for a System not Exceeding 4 Buses in Polar Coordinates.	
8		Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled Method for Both PQ and PV Buses.	
9		To Determine Fault Currents and Voltages in a Single Transmission Line System with	
10		Optimal Generation Scheduling for Thermal power plants by simulation. ■	
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">Develop a program in suitable package to assess the performance of medium and long transmission lines.Develop a program in suitable package to obtain the power angle characteristics of salient and non-salient pole alternator.Develop a program in suitable package to assess the transient stability under three phase fault at different locations in a of radial power systems.Develop programs in suitable package to formulate bus admittance and bus impedance matrices of interconnected power systems.Use suitable package to solve power flow problem for simple power systems.Use suitable package to study unsymmetrical faults at different locations in radial power systemsUse of suitable package to study optimal generation scheduling problems for thermal power plants. ■			

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII			
RELAY AND HIGH VOLTAGE LABORATORY			
Course Code	17EEL77	CIE Marks	40
Number of Practical Hours/Week	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none">To conduct experiments to verify the characteristics of over current, over voltage, under voltage relays both electromagnetic and static type.To verify the operation of negative sequence relay.To conduct experiments to verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.To conduct experiments on generator, motor and feeder protection.To conduct experiments to study the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.To measure high AC and DC voltagesTo experimentally measure the breakdown strength of transformer oil.To experimentally measure the capacitance of different electrode configuration models using Electrolytic Tank. To generate standard lightning impulse voltage and determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation. ■			
Sl. NO	Experiments		
Total of Six experiments are to be conducted by selecting Two experiments from each Part – A, Part – B and Part – C. Five out of six experiments are to be conducted under Part – D.			
1	Part - A	Over Current Relay: (a)Inverse Definite Minimum Time(IDMT)Non-Directional Characteristics (b) Directional Features (c) IDMT Directional.	
2		IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type).	
3		Operation of Negative Sequence Relay.	
4	Part - B	Operating Characteristics of Microprocessor Based (Numeric) Over –Current Relay.	
5		Operating Characteristics of Microprocessor Based (Numeric) Distance Relay.	
6		Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage	
7	Part - C	Generation Protection: Merz Price Scheme.	
8		Feeder Protection against Faults.	
9		Motor Protection against Faults.	
10	Part - D	Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected to Standard Temperature and Pressure for Uniform [as per IS1876: 2005]and Non-uniform [as per IS2071(Part 1) : 1993] Configurations: Sphere – Sphere, Point –Plane,	
11		Spark Over Characteristics of Air subjected to High voltage DC.	
12		Measurement of HVAC and HVDC using Standard Spheres as per IS 1876 :2005	
13		Measurement of Breakdown Strength of Transformer Oil as per IS 1876 :2005	
14		Field Mapping using Electrolytic Tank for any one of the following Models: Cable/ Capacitor/	
15		(a) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator. (b) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage.	

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

- Verify the characteristics of over current, over voltage, under voltage and negative sequence relay both electromagnetic and static type.
- Verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.
- Show knowledge of protecting generator, motor and feeders.
- Analyze the spark over characteristics for both uniform and non-uniform configurations using High A and DC voltages.
- Measure high AC and DC voltages and breakdown strength of transformer oil.
- Draw electric field and measure the capacitance of different electrode configuration models.
- Show knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation. ■

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■

B. E. ELECTRICAL AND ELECTRONICS ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – VIII

POWER SYSTEM OPERATION AND CONTROL(Core Course)

Course Code	17EE81	CIE Marks	40
Number of Lecture Hours/Week	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To describe various levels of controls in power systems and the vulnerability of the system.
- To explain components, architecture and configuration of SCADA.
- To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
- To explain automatic generation control, voltage and reactive power control in an interconnected power system.
- To explain reliability and contingency analysis, state estimation and related issues. ■

Module-1

Introduction: Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centers. R1

Supervisory Control and Data acquisition (SCADA): Introduction, components, application in Power System, basic functions and advantages. Building blocks of SCADA system, components of RTU, communication subsystem, IED functional block diagram. R2

Classification of SCADA system: Single master–single remote; Single master–multiple RTU; Multiple master–multiple RTUs; and Single master, multiple submaster, multiple remote. R2

Module-2

Automatic Generation Control (AGC): Introduction, Schematic diagram of load frequency and excitation voltage regulators of turbo generators, Load frequency control (Single area case), Turbine speed governing system, Model of speed governing system, Turbine model, Generator load model, Complete block diagram of representation of load frequency control of an isolated power system, Steady state analysis, Control area concept, Proportional plus Integral Controller. ■T1

Module-3

Automatic Generation Control in Interconnected Power system: Two area load frequency control, Optimal (Two area) load frequency control by state variable, Automatic voltage control, Load frequency control with generation rate constraints (GRCs), Speed governor dead band and its effect on AGC, Digital LF Controllers, Decentralized control. ■T1

Module-4

Control of Voltage and Reactive Power: Introduction, Generation and absorption of reactive power, Relation between voltage, power and reactive power at a node, Methods of voltage control: i. Injection of reactive power, Shunt capacitors and reactors, Series capacitors, Synchronous compensators, Series injection. ii Tap changing transformers. Combined use of tap changing transformers and reactive power injection, Booster transformers, Phase shift transformers, Voltage collapse. ■T3

Module-5				
Power System Security: Introduction, Factors affecting power system security, Contingency Analysis, Linear Sensitivity Factors, AC power flow methods, Contingency Selection and Ranking. T2				
State estimation of Power Systems: Introduction, Linear Least Square Estimation. ■T2				
Course Outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none"> Describe various levels of controls in power systems, architecture and configuration of SCADA. Develop and analyze mathematical models of Automatic Load Frequency Control. Develop mathematical model of Automatic Generation Control in Interconnected Power system Discuss the Control of Voltage , Reactive Power and Voltage collapse. Explain security, contingency analysis, state estimation of power systems. ■ 				
Question paper pattern: <ul style="list-style-type: none"> The question paper will have ten questions. Each full question is for 20 marks. There will be 2 full questions (with a maximum of three sub questions in one full question) from each module. Each full question with sub questions will cover the contents under a module. Students will have to answer 5 full questions, selecting one full question from each module. ■ 				
Text Book				
1	Modern Power System Analysis	D. P. Kothari	McGraw Hill	4 th Edition, 2011
2	Power Generation Operation and Control	Allen J Wood etal	Wiley	2nd Edition,2003
3	Electric Power Systems	B M Weedy, B J	Wiley	4 th Edition, 2012
Reference Books				
1	Computer-Aided Power System Analysis	G. L. Kusic	CRC Press	2nd Edition.2010
2	Power System SCADA and Smart Grid	Mini S Thom and John D. McDonald	CRC Press	2015
3	Power System Stability and Control	Kundur	McGraw Hill	8 th Reprint, 2009

INDUSTRIAL DRIVES AND APPLICATIONS(Core Course)			
B.E., VIII Semester, Electrical and Electronics Engineering [As per			
Choice Based Credit System (CBCS) scheme]			
Course Code	17EE82	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
Credits - 04			
Course objectives:			
<ul style="list-style-type: none">To define electric drive, its parts, advantages and explain choice of electric drive.To explain dynamics and modes of operation of electric drives.To explain selection of motor power ratings and control of dc motor using rectifiers.To analyze the performance of induction motor drives under different conditions.To explain the control of induction motor, synchronous motor and stepper motor drives.To discuss typical applications electrical drives in the industry. ■			
Module-1			Teaching Hours
Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives. Dynamics of Electrical Drives: Fundamental Torque Equations, Speed TorqueConventions and Multiquadrant Operation. Equivalent Values of DriveParameters, Components of Load Torques, Nature and Classification of LoadTorques, Calculation of Time and Energy Loss in Transient Operations, SteadyState Stability, Load Equalization. Control Electrical Drives: Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives. ■			10
Revised Bloom's Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding, L ₃ – Applying, L ₄ – Analysing.		
Module-2			
Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. Direct Current Motor Drives: Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor,SinglePhase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor,Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multiquadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier,Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current,Chopper Control of Separately Excited dcMotor, Chopper Control of Series Motor. ■			10
Revised Bloom's Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding, L ₃ – Applying, L ₄ – Analysing.		
Module-3			
Induction Motor Drives: Analysis and Performance ofThree Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing,Operation with Unbalanced Rotor Impedances,Analysis of Induction Motor Fed From Non-Sinusoidal Voltage Supply,Starting, Braking, Transient Analysis.Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources. ■			10
Revised Bloom's Taxonomy Level	L ₂ – Understanding, L ₃ – Applying, L ₄ – Analysing, L ₅ – Evaluating.		
Module-4			
Induction Motor Drives (continued): Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control and Converter Rating for VSI and Cycloconverter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control,current regulated voltage source inverter control, speed control of single phase induction motors. Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor			10
Revised Bloom's Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding, L ₃ – Applying, L ₄ – Analysing.		

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VIII				
17EE82 INDUSTRIAL DRIVES AND APPLICATIONS(Core Course) (continued)				
Module-5				Teaching Hours
Synchronous Motor Drives (continued): Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor. Industrial Drives: Textile Mills, Steel Rolling Mills, Cranes and Hoists, MachineTools.				10
Revised Bloom's Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding, L ₃ – Applying, L ₄ – Analysing.			
Course outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">• Explain the advantages and choice of electricdrive.• Explain dynamics and different modes of operation of electric drives.• Suggest a motor for a drive and control of dc motor using controlled rectifiers.• Analyze the performance of induction motor drives under differentconditions.• Control induction motor, synchronous motor and stepper motor drives.• Suggest a suitable electrical drive for specific application in theindustry.				
Graduate Attributes (As per NBA) Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage.				
Question paper pattern: <ul style="list-style-type: none">• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.• There will be two full questions (with a maximum of four sub questions) from each module.• Each full question will have sub question covering all the topics under a module.				
Textbook				
1	Fundamentals of Electrical Drives	Gopal K. Dubey	Narosa Publishing House	2 nd Edition, 2001
2	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives under module 5.)	VedumSubrahmanyam	McGraw Hill	2 nd Edition, 2011
Reference Books				
1	Electric Drives	N.K De,P.K. Sen	PHI Learning	1 st Edition, 2009

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII		
17EE832 OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS (Professional Elective)(continued)		
Module-3 (continued)		Teaching Hours
minimum voltage,Calculating the minimum number of modules in a string,Matching current specifications,Matching modules to the inverter’s power rating,Losses in utility-interactive PV systems,Temperature of the PV module,Dirt and soiling,Manufacturer’s tolerance,Shading,Orientation and module tilt angle,Voltage drop,Inverter efficiency, Calculating system yield.		
Revised Bloom’s Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding.	
Module-4		
Installing Grid-connected PV Systems: PV array installation, DC wiring, Cabling routes and required lengths,Cable sizing, PV combiner box,System grounding/earthing, Inverter installation, Installation checklist, ,Interconnection with the utility grid, Required information for installation,Safety. System Commissioning: Introduction, Final inspection of system installation, Testing, Commissioning, System documentation. System Operation and Maintenance: System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, Other common problems. ■		08
Revised Bloom’s Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding.	
Module-5		
Marketing and Economics of Grid-connected PV Systems: Introduction, PV system costing,Valuing a PV system,Simple payback and financial incentives,Simple payback,Feed-in tariffs,Rebates,Tax incentives,Loans,Renewable portfolio standards and renewable energy certificates,Marketing,Insurance. Case Studies: Case studies A to G.		08
Revised Bloom’s Taxonomy Level	L ₁ – Remembering, L ₂ – Understanding.	
Course outcomes: At the end of the course the student will be able to: <ul style="list-style-type: none">• Discuss basics of solar resource data, its acquisition and usage.• Explain PV technology, buying the PV modules and connecting the modules to formarrays.• Explain the use of inverters, other system components, cabling used to connect the components and mounting methods of the PV system.• Assess the site for PV system installation.• Design a grid connected system and compute its size.• Explain installation, commissioning, operation and maintenance of PV systems.		

- Explain the types of financial incentives available, calculation of payback time

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, The Engineer and Society, Environment and Sustainability, Ethics, Individual and Team Work, Communication, Project Management and Finance, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

INTERNSHIP / PROFESSIONAL PRACTICE
B.E., VIII Semester, Electrical and Electronics Engineering [As per
Choice Based Credit System (CBCS) scheme]

Course Code	17EE84	CIE Marks	50
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	50

Credits - 02

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Revised Bloom's Taxonomy Level	L ₃ – Applying, L ₄ – Analysing, L ₅ – Evaluating, L ₆ – Creating
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Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroomwork.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.

**B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VIII**

17EE84INTERNSHIP / PROFESSIONAL PRACTICE(continued)

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (25 marks) and seminar (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman. ■

Semester End Examination

SEE marks for the project report (25 marks) and seminar (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -II			
B.E., VIII Semester, Electrical and Electronics Engineering			
[As per Choice Based Credit System (CBCS) scheme]			
Course Code	17EEP85	CIE Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	100
Credits - 06			
Course objectives: <ul style="list-style-type: none">To support independent learning.To guide to select and utilize adequate information from varied resources maintaining ethics.To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.To develop interactive, communication, organisation, time management, and presentation skills.To impart flexibility and adaptability.To inspire independent and team working.To expand intellectual capacity, credibility, judgement, intuition.To adhere to punctuality, setting and meeting deadlines.To instil responsibilities to oneself and others.To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.			
Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.			
Revised Bloom's Taxonomy Level	L ₃ – Applying, L ₄ – Analysing, L ₅ – Evaluating, L ₆ – Creating		
Course outcomes: <p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none">Present the project and be able to defend it.Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.Habituated to critical thinking and use problem solving skillsCommunicate effectively and to present ideas clearly and coherently in both the written and oral forms.Work in a team to achieve common goal.Learn on their own, reflect on their learning and take appropriate actions to improve it.			
Graduate Attributes (As per NBA): <p>Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.</p>			
Evaluation Procedure: <p>The Internal marks evaluation shall be based on project report and presentation of the same in a seminar.</p> <p>Project Report:50 marks. The basis for awarding the marks shall be the involvement of individual student of the project batch in carrying the project and preparation of project report. To be awarded by the internal guide in consultation with external guide if any.</p> <p>Project Presentation:50 marks. Each student of the project batch shall present the topic of Project Work Phase - II orally and/or through power point slides.</p> <p>The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairman.</p> <p>The student shall be evaluated based on:</p> <p>Presentation skill for 30 marks and ability in the Question and Answer session for 20 marks.■</p> <p>Semester End Examination</p> <p>SEE marks for the project (100 marks)shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) as per the University norms by the examiners appointed VTU.■</p>			

SEMINAR			
B.E., VIII Semester, Electrical and Electronics Engineering			
[As per Choice Based Credit System (CBCS) scheme]			
Course Code	17EES86	CIE Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	--
Credits - 01			
Course objectives:			
The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.			
Each student, under the guidance of a Faculty, is required to			
Choose, preferably, a recent topic of his/her interest relevant to the Course of Specialization.			
<ul style="list-style-type: none">• Carryout literature survey, organize the Course topics in a systematic order.• Prepare the report with own sentences.• Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.• Present the seminar topic orally and/or through power point slides.• Answer the queries and involve in debate/discussion.• Submit typed report with a list of references.			
The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■			
Revised Bloom's Taxonomy Level	L ₃ – Applying, L ₄ – Analysing, L ₅ – Evaluating, L ₆ – Creating		
Course outcomes:			
At the end of the course the student will be able to:			
<ul style="list-style-type: none">• Attain, use and develop knowledge in the field of electrical and electronics engineering and other disciplines through independent learning and collaborative study.• Identify, understand and discuss current, real-time issues• Improve oral and written communication skills• Explore an appreciation of the self in relation to its larger diverse social and academic contexts.			
Graduate Attributes (As per NBA):			
Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.			
Evaluation Procedure:			
The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairman.			
Marks distribution for internal assessment of the course 15EES86 seminar:			
Seminar Report: 30 marks			
Presentation skill:50 marks			
Question and Answer:20 marks. ■			