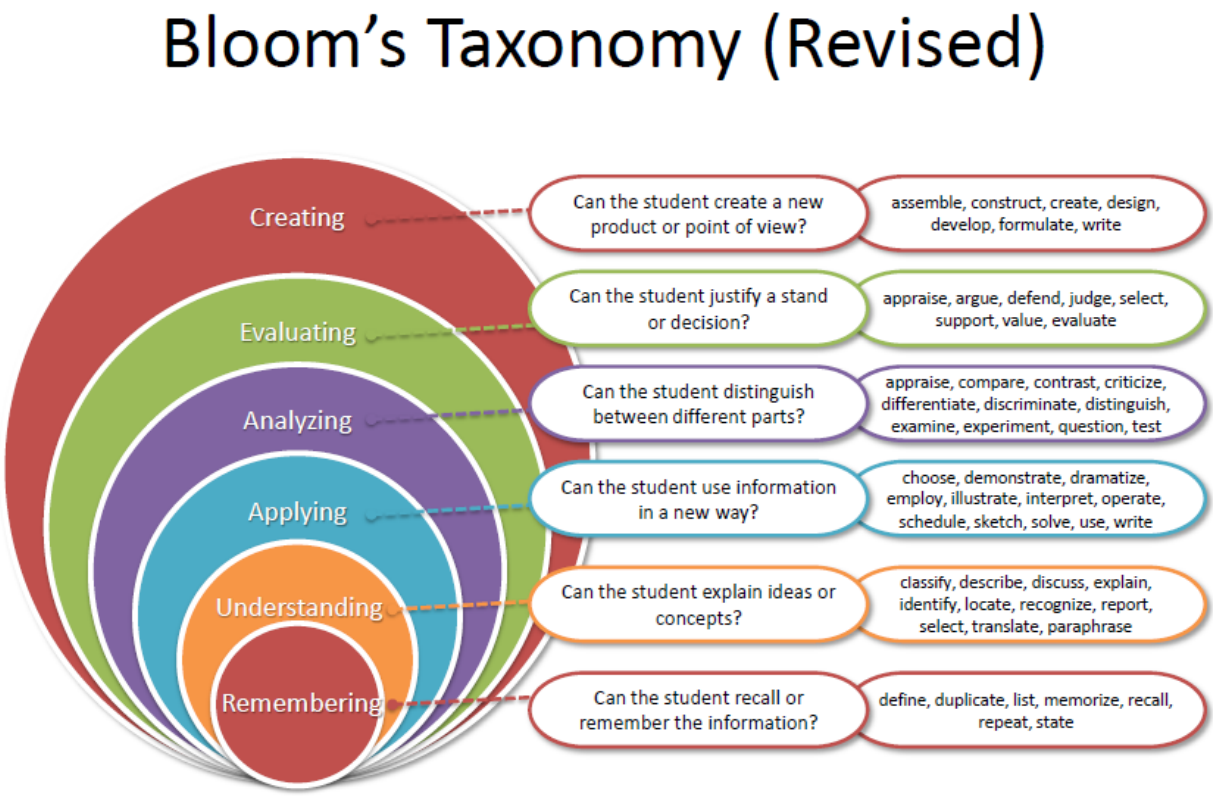
VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examination and Syllabus
B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
III TO VIII SEMESER

(Effective from Academic year 2015-16)

CATEGORIZATION FOR THE THINKING PROCESS



Bloom's Revised Taxonomy
Levels, Level Definitions and attributes levels
along with action verbs that can be used when developing learning outcomes.

	Level	Level Definitions and attributes	Verbs(not comprehensive)
Lower order thinking skills (LOTS)	Remembering (Knowledge) L_1	Students exhibit memory/rote memorization of previously learnt materials by recognition,recalling facts, terms, basic concepts, and simple answers. Able to remember, but not necessarily fully understanding the material.	Copy, Choose, Define, Discover, Describe, Duplicate, Enumerate, Find, How, Identify, Label, List, Locate, Listen, Memorize, Match, Name, Omit, Quote, Recall, Relate, Reproduce, Recognize, Select, Show, Spell, Tell, Tabulate, Who, When, Where etc.
	Understanding (Comprehension) L_2	Students demonstrate understanding of facts and ideas by interpreting, exemplifying, classifying, inferring, summarizing, comparing and explaining main ideas with own words.	Ask, Classify, Compare, Contrast, Demonstrate, Describe, Extend, Differentiate, Distinguish, Discuss, Express, Explain, Group, Illustrate, Infer, Interpret, Outline, Paraphrase, Rephrase, Relate, Show, Summarize, Select, Translate, Restate etc.
	Applying (Application) L_3	Students solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Calculate, Predict, Apply, Solve, Illustrate, Use, Demonstrate, Determine, Model, Build, Construct, Develop, Experiment With, Identify, Make Use Of, Organize, Plan, Select etc.
Higher order thinking skills (HOTS)	Analysing (Analysis) L_4	Students are able to examine and break information into component parts by identifying motives, causes arrangement, logic and semantics. They can make inferences and find evidence to support generalization.	Analyse, Assume, Break Down, Classify, Categorize, Conclusion, Compare, Contrast, Diagram, Discover, Dissect, Distinguish, Divide, Examine, Function, Illustrate, Inference, Inspect, List,Motive, Outline,Relationships, Simplify, Survey, Take Part In, Test For etc.
	Evaluating (Evaluation) L_5	Students are able to present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria. They can justify a decision or course of action.	Agree, Appraise, Assess, Award, Build, Create, Compose, Choose, Compare, Conclude, Criteria, Criticize, Design, Derive, Develop, Decide, Deduct, Determine, Disprove, Defend, Estimate, Formulate, Generate, Invent, Modify, Evaluate, Explain, Influence, Judge, Interpret, Justify, Mark, Measure, Perceive, Rate, Prioritize, Recommend, Rule On, Select, Support, Value etc.
	Creating (Synthesis) L_6	Students are able to compile, generate or view information,ideas or products together in a different way by combining elements in a new pattern or by proposing alternative solutions. Also, use information to form a unique product. This requires creativity and originality.	Assemble, Adapt, Anticipate, Build, Change, Choose, Combine, Collaborate, Collect, Create, Compile, Compose, Construct, Delete, Design, Develop, Discuss, Develop, Devise, Elaborate, Estimate, Formulate, Happen, Hypothesize, Imagine, Improve, Invent, Imagine, Intervene, Make Up, Maximize, Modify, Originate, Plan, Predict, Propose, Rearrange, Solve, Suppose, Substitute, Test etc.

Graduate attributes: Graduate attributes are the qualities, skills and understandings a university community agrees its students should develop during their time with the institution. These attributes include but go beyond the disciplinary expertise or technical knowledge that has traditionally formed the core of most university courses. They are qualities that also prepare graduates as agents of social good in an unknown future.

Bowden, Hart, King, Trigwell& Watts (2000)

Scheme of Teaching and Examination

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

III SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT31	Core Subject	Engineering Mathematics-III	Mathematics	04	--	03	20	80	100	4
2	15EE32	Core Subject	Electric Circuit Analysis	EEE	04	--	03	20	80	100	4
3	15EE33	Core Subject	Transformers and Generators	EEE	04	--	03	20	80	100	4
4	15EE34	Core Subject	Analog Electronic Circuits	EEE	04	--	03	20	80	100	4
5	15EE35	Core Subject	Digital System Design	EEE	04	--	03	20	80	100	4
6	15EE36	Foundation Course	Electrical and Electronic Measurements	EEE	04	--	03	20	80	100	4
7	15EEL37	Laboratory	Electrical Machines Laboratory -1	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEL38	Laboratory	Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
				TOTAL	**Theory:24 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**28**

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. FoundationCourse: The courses based upon the content that leads to Knowledge enhancement.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

IV SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15MAT41	Core Subject	Engineering Mathematics-IV	Maths	04	--	03	20	80	100	4
2	15EE42	Core Subject	Power Generation and Economics	EEE	04	--	03	20	80	100	4
3	15EE43	Core Subject	Transmission and Distribution	EEE	04	--	03	20	80	100	4
4	15EE44	Core Subject	Electric Motors	EEE	04	--	03	20	80	100	4
5	15EE45	Core Subject	Electromagnetic Field Theory	EEE	04	--	03	20	80	100	4
6	15EE46	Foundation Course	Operational Amplifiers and Linear ICs	EEE	04	--	03	20	80	100	4
7	15EEL47	Laboratory	Electrical Machines Laboratory -2	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEL48	Laboratory	Op- amp and Linear ICs Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
				TOTAL	**Theory:24 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**28**

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. **Foundation Course:**The courses based upon the content that leads to Knowledge enhancement.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

V SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE51	Core Subject	Management and Entrepreneurship	EEE	04	--	03	80	20	100	4
2	15EE52	Core Subject	Microcontroller	EEE	04	--	03	80	20	100	4
3	15EE53	Core Subject	Power Electronics	EEE	04	--	03	80	20	100	4
4	15EE54	Core Subject	Signals and Systems	EEE	04	--	03	80	20	100	4
5	15EE55X	Professional Elective	Professional Elective – I	EEE	03	--	03	80	20	100	3
6	15EE56Y	Open Elective	Open Elective - I	EEE	03	--	03	80	20	100	3
7	15EEL57	Laboratory	Microcontroller Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL58	Laboratory	Power Electronics Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
			TOTAL		**Theory:22hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**26**

Elective

Professional Elective		**Open Elective*** Offered by the Department of Electrical and Electronics Engineering**	
Courses under Code 15EE55X	**Title**	**Courses under Code 15EE55X**	**Title**
15EE551	Introduction to Nuclear Power	15EE561	Electronic Communication systems
15EE552	Electrical Engineering Materials	15EE562	Programmable Logic controllers
15EE553	Estimating and Costing	15EE563	Renewable Energy Systems
15EE554	Special Electrical Machines	15EE564	Business Communication

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided;

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Electives relevant to chosen specialization/ branch.

3. Open Elective: Electives from other technical and/ or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VI SEMESTER

Sl. No	Subject Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15EE61	Core Subject	Control Systems	EEE	04	--	03	80	20	100	4
2	15EE62	Core Subject	Power System Analysis – 1	EEE	04	--	03	80	20	100	4
3	15EE63	Core Subject	Digital Signal Processing	EEE	04	--	03	80	20	100	4
4	15EE64	Core Subject	Electrical Machine Design	EEE	04	--	03	80	20	100	4
5	15EE65X	Professional Elective	Professional Elective – II	EEE	03	--	03	80	20	100	3
6	15EE66Y	Open Elective	Open Elective - II	EEE	03	--	03	80	20	100	3
7	15EEL67	Laboratory	Control System Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
8	15EEL68	Laboratory	Digital Signal Processing Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	80	20	100	2
				TOTAL	**Theory:22 hours Practical: 06 hours**		**24**	**160**	**640**	**800**	**26**

Elective

Professional Elective		**Open Elective*** Offered by the Department of Electrical and Electronics Engineering**	
Courses under Code 15EE65X	**Title**	**Courses under Code 15EE66Y**	**Title**
15EE651	Computer Aided Electrical Drawing	15EE661	Artificial Neural Networks and Fuzzy logic
15EE652	Advanced Power Electronics	15EE662	Sensors and Transducers
15EE653	Energy Audit and Demand side Management	15EE663	Batteries and Fuel Cells for Commercial, Military and Space Applications
15EE654	Solar and Wind Energy	15EE664	Industrial Servo Control Systems

*** Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives). Selection of an open elective is not allowed provided;

- The candidate has pre – requisite knowledge.
- The candidate has not studied during I and II year of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters.

Registration to electives shall be documented under the guidance of Programme Coordinator and Adviser.

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Electives relevant to chosen specialization/ branch.

3. Open Elective: Electives from other technical and/ or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VII SEMESTER

Sl. No	Course Code	Subject (Course)	Title	Teaching Department	Teaching Hours/Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EE71	Core Subject	Power System Analysis - 2	EEE	04	--	03	20	80	100	4
2	15EE72	Core Subject	Power System Protection	EEE	04	--	03	20	80	100	4
3	15EE73	Core Subject	High Voltage Engineering	EEE	04	--	03	20	80	100	4
4	15EE74X	Professional Elective	Professional Elective – III	EEE	04	--	03	20	80	100	3
5	15EE75Y	Professional Elective	Professional Elective – IV	EEE	04	--	03	20	80	100	3
6	15EEL76	Laboratory	Power system Simulation Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
7	15EEL77	Laboratory	Rely and High Voltage Laboratory	EEE	01-Hour Instruction 02-Hour Practical		03	20	80	100	2
8	15EEP78	Project Phase – I + Seminar		EEE	--		--	100	--	100	2
			TOTAL		**Theory:24 hours Practical: 06 hours**		**21**	**240**	**560**	**800**	**24**

Elective

Professional Elective – III		**Professional Elective – IV**	
Courses under Code 15EE74X	**Title**	**Courses under Code 15EE75Y**	**Title**
15EE741	Advanced Control Systems	15EE751	FACTs and HVDC Transmission
15EE742	Utilization of Electrical Power	15EE752	Testing and Commissioning of Power System Apparatus
15EE743	Carbon Capture and Storage	15EE753	Spacecraft Power Technologies
15EE744	Power System Planning	15EE754	Industrial Heating

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch.

3. Project Phase –I + Seminar: Literature Survey, Problem Identification, objectives and Methodology. Submission of synopsis and seminar.

4. Internship / Professional Practice: To be carried between the VI and VIIsemester vacation or VII and VIII semester vacation period.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

SCHEME OF TEACHING AND EXAMINATION - 2015-16

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

CHOICE BASED CREDIT SYSTEM (CBCS)

VIII SEMESTER

Sl. No	Course Code	Subject (Course)	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
					Theory	Practical/ Drawing	Duration in hours	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15EE81	Core Subject	Power System Operation and Control	EEE	04	--	03	20	80	100	4
2	15EE82	Core Subject	Industrial Drives and Applications	EEE	04	--	03	20	80	100	4
3	15EE83X	Professional Elective	Professional Elective – V	EEE	03	--	03	20	80	100	3
4	15EE84	Core Subject	Internship / Professional Practice	EEE	Industry Oriented		03	50	50	100	2
5	15EEP85	Core Subject	Project Work Phase -II	EEE	--	06	03	100	100	200	6
6	15EES86	Core Subject	Seminar	EEE	--	04	--	100	--	100	1
			TOTAL		**Theory:11 hours Practical: 10 hours**		**15**	**310**	**390**	**700**	**20**

Professional Elective – V

Courses under Code 15EE83X	Title
15EE831	Smart Grid
15EE832	Operation and Maintenance of Solar Electric Systems
15EE833	Integration of Distributed Generation
15EE834	Power System in Emergencies

1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

2. Professional Elective: Elective relevant to chosen specialization/ branch.

3. Internship / Professional Practice: To be carried between the VI and VIIsemester vacation or VII and VIII semester vacation period.

III SEMESTER DETAILED SYLLABUS

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

ENGINEERING MATHEMATICS –III (Core Course)

Subject Code	15MAT31	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- The objectives of this course is to introduce students to the mostly used analytical and numerical methods in the different engineering fields by making them to learn Fourier series, Fourier transforms and Z-transforms, statistical methods , numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variations. ■

Module-1	**Teaching Hours**
Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period 2c. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from engineering field. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2	
Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transform. **Z-transform:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse z-transform. Applications of z-transforms to solve difference equations. ■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Statistical Methods: Review of measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –problems Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b, y = ax^2 + bx + c$ and $y = ae^{bx}$. Numerical Methods: Numerical solution of algebraic and transcendental equations by Regula-Falsi Method and Newton-Raphson method. ■	**10**
Revised Bloom's Taxonomy Level: L_3 – Applying.	
Module-4	
Finite differences: Forward and backward differences, Newton's forward and backward interpolation formulae. Divided differences- Newton's divided difference formula. Lagrange's interpolation formula and inverse interpolation formula (all formulae without proof)-Problems. **Numerical integration:** Simpson's $(1/3)^{th}$ and $(3/8)^{th}$ rules, Weddle's rule (without proof) – Problems. ■	**10**
Revised Bloom's Taxonomy Level: L_3 – Applying.	
Module-5	
Vector integration: Line integrals-definition and problems, surface and volume integrals-definition, Green's theorem in a plane, Stokes and Gauss-divergence theorem(without proof) and problems. **Calculus of Variations:** Variation of function and Functional, variational problems. Euler's equation, Geodesics, hanging chain, problems. ■	**10**
Revised Bloom's Taxonomy Level: L_3 – Applying, L_4 – Analysing. L_2 – Understanding, L_4 – Analysing.	

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

15MAT31 ENGINEERING MATHEMATICS –III (Core Subject) (continued)

Course outcomes:

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

- Know the use of periodic signals and Fourier series to analyze circuits and system communications.
- Explain the general linear system theory for continuous-time signals and digital signal processing using the Fourier Transform and z-transform.
- Employ appropriate numerical methods to solve algebraic and transcendental equations.
- Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems.
- Determine the extremals of functional and solve the simple problems of the calculus of variations. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Life-Long Learning, Accomplishment of Complex Problems.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module.

Text Books

1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
2	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10thEdition, 2015

Reference books

3	A Text Book of Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publishers	7th Edition, 2010
4	Higher Engineering Mathematics	B.V.Ramana	Tata McGraw-Hill	2006
5	Higher Engineering Mathematics	H. K.DassEr. RajnishVerma	S.Chand	First Edition,2011

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://wwww.khanacademy.org/
3. http://www.class-central.com/subject/math

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

ELECTRIC CIRCUIT ANALYSIS (Core Subject)

Subject Code	15EE32	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To familiarize the basic laws, source transformations, theorems and the methods of analysing electrical circuits.
- To explain the concept of coupling in electric circuits and resonance.
- To familiarize the analysis of three-phase circuits, two port networks and networks with non-sinusoidal inputs.
- To analyze the transient response of circuits with dc and sinusoidal ac input.
- To impart basic knowledge on network analysis using Laplace transforms. ■

Module-1		**Teaching Hours**
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. Equilibrium equations using KCL and KVL, Duality. **Resonant Circuits:** Analysis of simple series RLC and parallel RLC circuits under resonances. Resonant frequency, Bandwidth and Quality factor at resonance. Practical RL-RC circuits.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Network Theorems: Analysis of networks, with and without dependent ac and dc sources by Thevenin's and Norton's theorems. Analysis of ac and dc circuits for maximum power transfer to resistive and complex loads. Application of Millman's theorem and Super Position theorem to multisource networks. Reciprocity theorem and its application. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Transient Analysis: Review of ordinary linear non homogeneous first and second order differential equations with constant coefficients. Transient analysis of ac and dc circuits by classical method. Transient analysis of dc and ac circuits. Behaviour of circuit elements under switching action ($t = 0$ and $t = \infty$). Evaluation of initial conditions. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
Laplace Transformation: Laplace transformation (LT), LT of Impulse, Step, Ramp, Sinusoidal signals and shifted functions. Waveform synthesis. Initial and Final value theorems. Laplace Transform of network and time domain solution for RL, RC and RLC networks for ac and dc excitations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Unbalanced Three phase systems: Analysis of three phase systems, calculation of real and reactive powers. **Two Port networks:** Definition, Open circuit impedance, Short circuit admittance and Transmission parameters and their evaluation for simple circuits. Network functions of one port and two port		**10**

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

15EE32 ELECTRIC CIRCUIT ANALYSIS (Core Course) (continued)

Module-5(continued)		**Teaching Hours**
Two Port networks (continued): networks, properties of poles and zeros of network functions. **Complex Wave analysis:** Analysis of simple circuits with non-sinusoidal excitation. ■		
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:

- Apply knowledge of mathematics, science, and engineering to the analysis and design of electrical circuits.
- Identify, formulate, and solve engineering problems in the area circuits and systems.
- Analyze the solution and infer the authenticity of it.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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. ■

Text/Reference Books

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

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

TRANSFORMERS AND GENERATORS (Core Course)

Subject Code	15EE33	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- 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	**Teaching Hours**
Single phase Transformers: Review of Principle of operation, constructional details of shell type and core type single-phase transformers, EMF equation, losses and commercial efficiency, conditions for maximum efficiency (No question shall be set from the review portion). Salient features of ideal transformer, operation of practical transformer under no - load and on - load with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of equivalent circuit parameters and predetermination of efficiency- commercial and all-day. 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, choice of connection. Phase conversion - Scott connection for three-phase to two-phase conversion. Labelling of three-phase transformer terminals, vector groups. Equivalent circuit of three phase transformers. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2	
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. **Autotransformers and Tap changing transformers:** Introduction to auto transformer - copper economy, equivalent circuit, three phase auto connection and voltage regulation. Voltage regulation by tap changing – off circuit and on load. **Tertiary winding Transformers:** Necessity of tertiary winding, equivalent circuit and voltage regulation, tertiary winding in star/star transformers, rating of tertiary winding.■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Transformers (continuation): Cause and effects of harmonics, Current inrush in transformers, noise in transformers. Objects of testing transformers, polarity test, Sumpner's test. **Direct current Generator –** Review of construction, types, armature windings, relation between no load and terminal voltage (No question shall be set from the review portion). Armature reaction, Commutation and associated problems, no load and full load characteristics. Reasons for reduced dependency on dc generators. **Synchronous generators-** Review of construction and operation of salient & non-salient pole synchronous generators (No question shall be set from the review portion). Armature windings, winding factors, emf equation. Harmonics – causes, reduction and elimination. Armature reaction, Synchronous reactance, Equivalent circuit.■	**10**
Revised Bloom's Taxonomy Level: L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4	
Synchronous generators (continuation): Generator load characteristic. Voltage regulation, excitation control for constant terminal voltage. Generator input and output. Parallel operation of	**10**

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

15EE33 TRANSFORMERS AND GENERATORS (Core Course) (continued)

Module-4(continued)		**Teaching Hours**
Synchronous generators(continuation): generators and load sharing. Synchronous generator on infinite bus-bars – General load diagram, Electrical load diagram, mechanical load diagram, O – curves and V – curves. Power angle characteristic and synchronizing power. **Synchronous generators(continuation):** Effects of saliency, two-reaction theory, Direct and Quadrature reactance, power angle diagram, reluctance power, slip test. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Synchronous generators(continuation): Open circuit and short circuit characteristics, Assessment of reactance- short circuit ratio, synchronous reactance, adjusted synchronous reactance and Potier reactance. Voltage regulation by EMF, MMF, ZPF and ASA methods. **Performance of synchronous generators:** Capability curve for large turbo generators and salient pole generators. Starting, synchronizing and control. Hunting and dampers. ■		**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:

- Explain the construction and operation and performance of transformers.
- Explain different connections for the three phase operations, their advantages and applications.
- Explain the construction and operation of Synchronous machines and evaluate the regulation of synchronous machines by different methods.
- Analyze the operation of the synchronous machine connected to infinite machine.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books

1	Electric Machines	D. P. Kothari, et al	McGraw Hill	4th Edition, 2011
2	Performance and Design of A.C. Machines	M. G. Say	CBS Publishers	3rd Edition, 2002
3	Principles of Electric Machines and power Electronics	P.C.Sen	Wiley	2nd Edition, 2013
4	Electric Machines	MulukuntlaS.Sarma,at el	Cengage	1st Edition, 2009
5	Electrical Machines, Drives and Power systems	Theodore Wildi	Pearson	6th Edition, 2014
6	Electrical Machines	M.V. Deshpande	PHI Learning	1st Edition, 2013
7	Electrical Machines	AbhijitChakrabarti et al	McGraw Hill	1st Edition, 2015
8	A Textbook of Electrical Machines	K.R.SiddapuraD.B.Raval	Vikas	1st Edition, 2014

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

ANALOG ELECTRONIC CIRCUITS (Core Course)

Subject Code	15EE34	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- Provide the knowledge for the analysis of diode and transistor circuits.
- Develop skills to design the electronic circuits like amplifiers and oscillators.
- Highlight the importance of FET and MOSFET.■

Module-1		**Teaching Hours**
Diode Circuits: Review of diodes as rectifiers (No question shall be set from review portion). 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 switching circuits:** Transistor switching circuits,PNP transistors, thermal compensation techniques. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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. **Transistor frequency response:** General frequency considerations, low frequency response, Miller effect capacitance, high frequency response, multistage frequency effects. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-3		
Multistage amplifiers: Cascade and cascode connections, Darlington circuits, analysis and design. **Feedback amplifiers:** Feedback concept, different types, practical feedback circuits, analysis and design of feedback circuits. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Power amplifiers: Amplifier types, analysis and design of different power amplifiers, distortion in 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. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
FETs: Construction, working andcharacteristics of JFET and MOSFET. Biasing of JFET and MOSFET, JFET and MOSFET amplifiers, analysis and design. ■		**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 - III

15EE34 ANALOG ELECTRONIC CIRCUITS (Core Subject) (continued)

Course outcomes:

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

- Utilize the characteristics of transistor for different applications.
- Design and analyze biasing circuits for transistor.
- Design, analyze and test transistor circuitry as amplifiers and oscillators.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books

1	Electronic Devices and Circuit Theory	Robert L Boylestad Louis Nashelsky	Pearson	11th Edition, 2015
2	Integrated Electronics, Analysis and Digital Circuits and Systems	Jacob Millman et al	McGraw Hill	2nd Edition, 2009
3	Electronic Devices and Circuits	David A Bell	Oxford University Press	5th Edition, 2008
4	Microelectronics Circuits Analysis and Design	Muhammad Rashid	Cengage Learning	2nd Edition, 2014
5	A Text Book of Electrical Technology, Electronic Devices and Circuits	B.L. Theraja, A.K. Theraja,	S. Chand	Reprint, 2013
6	Electronic Devices and Circuits	Anil K. Maini VashaAgarval	Wiley	1st Edition, 2009
7	Electronic Devices and Circuits	S.Salivahanan N.Suresh	McGraw Hill	3rd Edition, 2013
8	Fundamentals of Analog Circuits	Thomas L Floyd	Pearson	2nd Edition, 2012

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

DIGITAL SYSTEM DESIGN(Core Course)

Subject Code	15EE35	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To impart the knowledge of combinational circuit design.
- To impart the knowledge of Sequential circuit design.
- To provide the basic knowledge about VHDL & its use.■

Module-1	**Teaching Hours**
Principles of combinational logic: Definition of combinational, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 and 5 variables. Incompletely specified functions (Don't care terms). Simplifying max - term equations. Quine -McClusky minimization technique, Quine - McClusky using don't care terms, Reduced Prime Implicant tables, Map entered variables. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Analysis and design of Combinational Logic: General approach, Decoders-BCD decoders, Encoders. Digital multiplexers-using multiplexers as Boolean function generators. Adders and Subtractors-Cascading full adders, Look ahead carry, Binary comparators. Design methods of building blocks of combinational logics.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Sequential Circuits: Basic Bistable element, Latches, SR latch, application of SR latch, A Switch debouncer, The SR latch, The gated SR latch. The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The master-slave SR Flip-Flops, The master-slave JK Flip-Flop, Edge Triggered Flip-flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop. Characteristic equations, Registers, Counters-Binary Ripple Counter, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters, Design of a Synchronous Mod-6 counters using clocked JK Flip-Flops Design of a Synchronous Mod-6 counter using clocked D, T, or SR Flip-Flops. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Sequential Design: Introduction, Mealy and Moore models, State machine notation, synchronous sequential circuit analysis and design. Construction of state Diagrams, Counters Design. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
HDL: Introduction, A brief history of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, Simulation and synthesis, Brief comparison of VHDL and Verilog. **Data-Flow Descriptions**: Highlights of Data flow descriptions, Structure of data-flow description, Data type-vectors. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

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

15EE35 DIGITAL SYSTEM DESIGN (Core Course) (continued)

Course outcomes:

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

- Design and analyze combinational & sequential circuits
- Design circuits like adder, sub tractor, code converter etc.
- Understand counters and sequence generators.

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books

1	Digital Logic Applications and	John M Yarbrough	CengageLearn	2011
2	Digital Principles and Design	Donald D Givone	McGraw Hill	1st Edition, 2002
3	Logic and computer design Fundamentals	M. Morries Mano and Charles Kime	Pearson Learning	4th Edition, 2014
4	Fundamentals of logic design	Charles H Roth, JR and Larry L. Kinney	Cengage Learning	6th Edition, 2013
5	Fundamentals of Digital Circuits	A. Anand Kumar	PHI	3rd Edition, 2014
6	Digital Logic Design and VHDL	A.A.Phadke, S.M.Deokar	Wiley India	1st Edition, 2009
7	Digital Circuits and Design	D.P.KothariJ.S.Dhillon	Pearson	First Print 2015
8	HDL Programming (VHDL and Verilog)	Nazeih M. Botros	Cengage Learning	1st Edition, 2011
9	Circuit Design and Simulation with VHDL	Volnei A Pedroni	PHI	2nd Edition,

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

ELECTRICAL AND ELECTRONIC MEASUREMENTS (Foundation Course)

Subject Code	15EE36	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To understand the concept of units and dimensions.
- To measure resistance, inductance, capacitance by use of different bridges.
- To study the construction and working of various meters used for measurement.
- To have the working knowledge of electronic instruments and display devices. ■

Module-1	**Teaching Hours**
Units and Dimensions: Review of fundamental and derived units. SI units (No question shall be set from the review portion). Dimensional equations, problems. **Measurement of Resistance:** Wheatstone's bridge, sensitivity, limitations. Kelvin's double bridge. Earth resistance measurement by fall of potential method and by using Megger. **Measurement of Inductance and Capacitance:** Sources and detectors, Maxwell's inductance bridge, Maxwell's inductance and capacitance bridge, Hay's bridge, Anderson's bridge, Desauty's bridge, Schering bridge. Shielding of bridges. Problems. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Measurement of Power, Energy, Power factor and Frequency: Review ofDynamometer wattmeter construction and operation (No question shall be set from the review portions), Torque expression, Errors and minimization, UPF and LPF wattmeters. Measurement of real and reactive power in 3 phase circuits. Review of Induction type energy meter construction and operation (No question shall be set from the review portions)]. Errors, adjustments and calibration of single and three phase energy meters, Problems. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Extension of Instrument Ranges: Desirable features of ammeters and voltmeters.Shunts and multipliers. Construction and theory of instrument transformers, Desirable characterises, Errors of CT and PT. Turns compensation, Illustrative examples, Silsbee's method of testing CT. **Magnetic measurements:** Introduction, measurement of flux/ flux density, magnetising force and leakage factor. Hopkinson permeameter. Measurement of iron loss by wattmeter method. A brief discussion on measurement of air gap flux and field strength.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Electronic and digital Instruments: Introduction. Essentials of electronic instruments, Advantages of electronic instruments. True rms reading voltmeter. Electronic multimeters. Digital voltmeters (DVM) - Ramp type DVM, Integrating type DVM, Continuous – balance DVM and Successive - approximation DVM. Q meter. Principle of working of electronic energy meter (block diagram treatment), extra features offered by present day meters and their significance in billing.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

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

15EE36 ELECTRICAL AND ELECTRONIC MEASUREMENTS (Foundation Course) (continued)

Module-5	**Teaching Hours**
Display Devices: Introduction, character formats, segment displays, Dot matrix displays, Bar graph displays. Cathode ray tubes, Light emitting diodes, Liquid crystal displays, Nixes, Incandescent, Fluorescent, Liquid vapour and Visual displays. Display multiplexing and zero suppression. **Recording Devices:** Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and xy recorders. Magnetic tape recorders, Direct recording, Frequency modulation recording, Pulse duration modulation recording, Digital tape recording, Ultraviolet recorders. Biomedical recorders, Electro Cardio Graph (ECG),Electroencephalograph, Electromyograph. Noise in reproduction. ■	**10**
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:

- Explain the importance of units and dimensions.
- Measure resistance, inductance and capacitance by different methods.
- Explain the working of various meters used for measurement of power and energy.
- Explain the working of different electronic instruments and display devices.

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books

1	Electrical and electronic Measurements and Instrumentation	A.K. Sawhney	DhanpatRai and Co	10th Edition
2	A Course in Electronics and Electrical Measurements and Instrumentation	J. B. Gupta	Katson Books	2013 Edition
3	Electrical and electronic Measurements and Instrumentation	Er.R.K. Rajput	S Chand	5th Edition, 2012
4	Electrical Measuring Instruments and Measurements	S.C. Bhargava	BS Publications	2013
5	Modern Electronic Instrumentation and Measuring Techniques	Cooper D and A.D. Heifrick	Pearson	First Edition, 2015
6	Electronic Instrumentation and Measurements	David A Bell	Oxford University	3rd Edition, 2013
7	Electronic Instrumentation	H.S.Kalsi	McGraw Hill	3rd Edition,2010

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

ELECTRICAL MACHINES LABORATORY - 1

Subject Code	15EEL37	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course objectives:

- 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 predetermination 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 sharing and analytical verification given the Short circuit test data.
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	Slip test – Measurement of direct and quadrature axis reactance and predetermination of regulation of salient pole synchronous machines.
11	Performance of synchronous generator connected to infinite bus, under constant power and variable excitation & vice - versa.
12	Power angle curve of synchronous generator.

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:

- Conduct different tests on transformers and synchronous generators and evaluate their performance.
- Connect and operate two single phase transformers of different KVA rating in parallel.
- Connect single phase transformers for three phase operation and phase conversion.
- Assess the performance of synchronous generator connected to infinite bus.

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis, Individual and Team work,Communication.

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 (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - III

ELECTRONICS LABORATORY

Subject Code	15EEL38	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course objectives:

- 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, 74193.

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:

- Design and test different diode circuits.
- Design and test amplifier and oscillator circuits and analyse their performance.
- Use universal gates and ICs for code conversion and arithmetic operations.
- Design and verify on of different counters.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

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.■

****** END ******

IV SEMESTER DETAILED SYLLABUS

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

ENGINEERING MATHEMATICS –IV (Core Subject)

Subject Code	15MAT41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:
The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.■

Module-1		**Teaching Hours**
Numerical Methods: Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae). ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying.	
Module-2		
Numerical Methods: Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne's method. **Special Functions:** Series solution-Frobenious method. Series solution of Bessel's differential equation leading to $J_n(x)$-Bessel's function of first kind. Basic properties, recurrence relations and orthogonality. Series solution of Legendre's differential equation leading to $P_n(x)$-Legendre polynomials. Rodrigue's formula, problems.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying.	
Module-3		
Complex Variables: Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula, Residue, poles, Cauchy's Residue theorem (without proof) and problems. **Transformations:** Conformal transformations, discussion of transformations: $w = z^2, w = e^z, w = z + (1/z)(z \neq 0)$and bilinear transformations-problems.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – ApplyingL_4 – Analysing.	
Module-4		
Probability Distributions: Random variables (discrete and continuous),probability mass/density functions. Binomial distribution, Poisson distribution.Exponential and normal distributions, problems. **Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying.	
Module-5		
Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **Stochastic process:** Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – ApplyingL_4 – Analysing.	

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

15MAT41 ENGINEERING MATHEMATICS – IV (Core Subject) (continued)

Course outcomes:

- Use appropriate single step and multi-step numerical methods to solve first and second order ordinary differential equations arising in flow data design problems.
- Explain the idea of analyticity, potential fields residues and poles of complex potentials in field theory and electromagnetic theory.
- Employ Bessel's functions and Legendre's polynomials for tackling problems arising in continuum mechanics, hydrodynamics and heat conduction.
- Describe random variables and probability distributions using rigorous statistical methods to analyze problems associated with optimization of digital circuits, information, coding theory and stability analysis of systems.
- Apply the knowledge of joint probability distributions and Markov chains in attempting engineering problems for feasible random events.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Life-Long Learning, Accomplishment of Complex Problems.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Text Books:

1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
2	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2015

Reference books:

3	A Text Book of Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publishers	7th Edition, 2010
4	Higher Engineering Mathematics	B.V.Ramana	McGraw-Hill	2006
5	Higher Engineerig Mathematics	H. K. Dass and Er. RajnishVerma	S.Chand publishing	First Edition, 2011

Web links and Video Lectures

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://wwww.khanacademy.org/
3. http://www.class-central.com/subject/math

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

POWER GENERATION AND ECONOMICS(Core Subject)

Subject Code	15EE42	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- Explain the arrangement and operation of hydroelectric, steam, diesel, gas turbine and nuclear power plants and working of major equipment in the plants.
- Classification of substation and explain the operation of different substation equipment.
- Explain the importance of grounding and different grounding methods used in practice.
- Explain the economics of power generation and importance of power factor.

Module-1	**Teaching Hours**
Hydroelectric Power Plants: Hydrology, run off and stream flow, hydrograph, flow duration curve, Mass curve, reservoir capacity, dam storage. Hydrological cycle, merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, elements of the plant, Classification of the plants based on water flow regulation, water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines Governing of turbines, selection of water turbines. Underground, small hydro and pumped storage plants. Choice of size and number of units, plant layout and auxiliaries. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Steam Power Plants: Introduction,Efficiency of steam plants, Merits and demerits of plants, selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling, Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, plant auxiliaries. **Diesel Power Plant:** Introduction, Merits and demerits, selection site, elements of diesel power plant, applications. **Gas Turbine Power Plant**: Introduction, Merits and demerits, selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants. Comparison of gas power plant with steam and diesel power plants. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Nuclear Power Plants: Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels, Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, shielding.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-4	
Substations: Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments, and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation, Busbar arrangement schemes and single line diagrams of substations.	**10**

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

15EE42 POWER GENERATION AND ECONOMICS(Core Subject) (continued)

Module-4 (continued)		**Teaching Hours**
Substations (continued): Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation. **Grounding:** Introduction, Difference between grounded and ungrounded system. System grounding – ungrounded, solid grounding, resistance grounding, reactance grounding, resonant grounding. Earthing transformer. Neutral grounding and neutral grounding transformer. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Module-5		
Economics: Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, disadvantages, causes, methods of improving power factor, Advantages of improved power factor, economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment. ■		**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:

- Describe the working of hydroelectric, steam, nuclear power plants and state functions of major equipment of the power plants.
- Classify various substations and explain the importance of grounding.
- Understand the economic aspects of power system operation and its effects.
- Explain the importance of power factor improvement.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Engineers and Society, Environment and Sustainability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books

1	A Course in Power Systems	J.B. Gupta	Katson	2008
2	Generation of Electrical Energy	B.R.Gupta	S. Chand	2015
3	Electrical power Generation, Transmission and Distribution	S.N. Singh	PHI	2nd Edition, 2009
4	Power Plant Engineering	P.K. Nag	McGrawHill	4th Edition, 2014
5	Electrical Power Distribution Systems	V. Kamaraju	McGrawHill	1st Edition, 2009
6	Electrical Distribution Engineering	Anthony J. Pansini	CRC Press	3rd Edition, 2006
7	Electrical Distribution Systems	Dale R PatrickEt al	CRC Press	2nd Edition, 2009
8	A Text Book on Power System Engineering	A.Chakrabarti, et al	DhanpathRai	2nd Edition, 2010

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

TRANSMISSION AND DISTRIBUTION (Core Subject)

Subject Code	15EE43	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:

- To understand the concepts of various methods of generation of power.
- To understand the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- To design insulators for a given voltage level.
- To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
- To study underground cables for power transmission and evaluate different types of distribution systems.

Module-1	**Teaching Hours**
Introduction to power system: Structure of electric power system: generation, transmission and distribution. Advantages of higher voltage transmission: HVAC, EHVAC, UHVAC and HVDC. Interconnection. Feeders, distributors and service mains. **Overhead transmission lines:** A brief introduction to types of supporting structures and line conductors-Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All – aluminium alloy conductor (AAAC) and All –aluminium conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI),Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminium alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, effect of wind and ice. Line vibration and vibration dampers. Overhead line protection against lightening; ground wires. **Overhead line Insulators:** A brief introduction to types of insulators, material used- porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns. ■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding.	
Module-2	
Line parameters: Introduction to line parameters- resistance, inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Inductance of composite – conductors, geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of composite – conductor, geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines. ■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3	
Performance of transmission lines: Classification of lines – short, medium and long. Current and voltage relations, line regulation and Ferranti effect in short length lines, medium length lines considering Nominal T and nominal π circuits, and long lines considering hyperbolic form equations. Equivalent circuit of a long line. ABCD constants in all cases. ■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Corona: Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.	**10**

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

15EE43 TRANSMISSION AND DISTRIBUTION (Core Subject) (continued)

Module-4 (continued)	**Teaching Hours**
Underground cable: Types of cables, constructional features, insulation resistance, thermal rating, charging current, grading of cables – capacitance and inter-sheath.Dielectric loss. Comparison between ac and dc cables. Limitations of cables.Specification of power cables. ■	
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
Distribution: Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution, AC distributors with concentrated and uniform loads. Effect of disconnection of neutral in a 3 phase four wire system. **Reliability and Quality of Distribution system:** Introduction, definition of reliability, failure, probability concepts, limitation of distribution systems, power quality, Reliability aids. ■	**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:

- Explain the concepts of various methods of generation of power.
- Explain the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- Design and analyze overhead transmission system for a given voltage level.
- Calculate the parameters of the transmission line for different configurations and assess the performance of line.
- Explain the use of underground cables and evaluate different types of distribution systems.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design / development of solutions, Engineers and society, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books:

1	A Course in Electrical Power	Soni Gupta and Bhatnagar	DhanpatRai	-
2	Power System Analysis and Design	J. Duncan Gloverat el	Cengage Learning	4th Edition 2008
3	Principles of Power System	V.K. Mehta, Rohit Mehta	S. Chand	1st Edition 2013
4	Electrical power Generation, Transmission and Distribution	S.N. Singh	PHI	2nd Edition,2009
5	Electrical Power	S.L.Uppal	Khanna Publication	
6	Electrical power systems	C. L. Wadhwa	New Age	5th Edition, 2009
7	Electrical power systems	AshfaqHussain	CBS Publication	
8	Electric Power Distribution	A.S. Pabla	McGraw-Hill	6th Edition,2012
9	*For* High temperature conductors refer www.jpowers.co.jp/english/product/pdf/gap_c1.pdfand Power System Analysis and Design, J. Duncan Glover at el			

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

ELECTRIC MOTORS (Core Subject)

Subject Code	15EE44	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:

- 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	**Teaching Hours**
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. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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**.** ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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; standalone operation and grid connected operation. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.	**10**

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

15EE44 ELECTRIC MOTORS (Core Subject) (continued)

Module-5 (continued)		**Teaching Hours**
Other motors: Construction and operation of Universal motor, AC servomotor, Linear induction motor and stepper motors.■		
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:

- Explain the constructional features of Motors and select a suitable drive for specific application.
- Analyze and assess the performance characteristics of DC motors by conducting suitable tests and control the speed by suitable method.
- Explain the constructional features of Three Phase and Single phase induction Motors and assess their performance.
- Control the speed of induction motor by a suitable method.
- Explain the operation of Synchronous motor and special motors.

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books:

1	Electric Machines	D. P. Kothari, I. J. Nagrath	McGraw Hill	4th edition, 2011
2	Principles of Electric Machines and power Electronics	P.C.Sen	Wiley	2nd Edition, 2013
3	Electric Machines	R.K. Srivastava	Cengage Learning	2nd Edition,2013
4	Electrical Machines, Drives and Power systems	Theodore Wildi	Pearson	6th Edition, 2014
5	Electrical Machines	M.V. Deshpande	PHI Learning	2013
6	Electric Machinery and Transformers	Bhag S Guru at el	Oxford University Press	3rd Edition, 2012
7	Electric Machinery and Transformers	Irving Kosow	Pearson	2rd Edition, 2012
8	Theory of Alternating Current Machines	Alexander Langsdorf	McGraw Hill	2nd Edition, 2001

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

ELECTROMAGNETIC FIELD THEORY (Core Subject)

Subject Code	15EE45	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:

- 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	**Teaching Hours**
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. Problems. **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. Problems. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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. Problems. **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. Capacitance of two wire line. Problems. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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. Problems.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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. Problems. **Magnetic materials and magnetism:** Nature of magnetic materials, magnetisation and permeability. Magnetic boundary conditions. Magnetic circuit, inductance and mutual inductance. Problems.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

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

15EE45 ELECTROMAGNETIC FIELD THEORY (Core Subject) (continued)

Module-5	**Teaching Hours**
Time varying fields and Maxwell's equations: Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Problems. **Uniform plane wave:** Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Problems. ■	**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:

- Use different coordinate systems to explain the concept of gradient, divergence and curl of a vector.
- Use 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 between a conductor and dielectric and between two different dielectrics.
- Explain the behavior of magnetic fields and magnetic materials.
- Assess time varying fields and propagation of waves in different media.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books:

1	Engineering Electromagnetics	William H Hayt et al	McGraw Hill	8thEdition, 2014
2	Principles of Electromagnetics	Matthew N. O. Sadiku	Oxford	6th Edition, 2015
3	Fundamentals of Engineering Electromagnetics	David K. Cheng	Pearson	2014
4	Electromagnetism -Theory (Volume -1) -Applications (Volume-2)	AshutoshPramanik	PHI Learning	2014
5	Electromagnetic Field Theory Fundamentals	Bhag Guru et al	Cambridge	2005
6	Electromagnetic Field Theory	RohitKhurana	Vikas Publishing	1st Edition,2014
7	Electromagnetics	J. A. Edminister	McGraw Hill	3rd Edition, 2010
8	Electromagnetic Field Theory and Transmission Lines	GottapuSasibhushana Rao	Wiley	1st Edition, 2013

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

OPERATIONAL AMPLIFIERS AND LINEAR ICs (Foundation Course)

Subject Code	15EE46	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course Objectives:

- 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	**Teaching Hours**
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 ; voltage series feedback amplifier-gain, input resistance, output resistance, voltage shunt feedback amplifier- gain, input resistance, output resistance. **General Linear Applications:** D.C. & A.C amplifiers, peaking amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, differential configuration, instrumentation amplifier.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2	
Active Filters: First & Second order high pass & low pass Butterworth filters, higher order filters Band pass filters, Band reject filters & all pass filters. **DC Voltage Regulators:** voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Signal generators: Triangular / rectangular wave generator, phase shift oscillator, Wien bridge oscillator, oscillator amplitude stabilization, signal generator output controls. **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.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Signal processing circuits: Precision half wave & full wave rectifiers limiting circuits, clamping circuits, peak detectors, sample & hold circuits. **A/D & D/A Converters:** Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC, dual slope ADC, digital ramp ADC. ■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
Phase Locked Loop (PLL): Basic PLL, components, performance factors, applications of PLL IC 565. **Timer:** Internal architecture of 555 timer, Mono stable, Astable multivibrators and applications. ■	**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 -IV

15EE46 OPERATIONAL AMPLIFIERS AND LINEAR ICs (Foundation Course) (continued)

Course Outcomes:

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

- Explain the basics of linear ICs.
- Design circuits using linear ICs.
- Demonstrate the application of Linear ICs.
- Use ICs in the electronic projects.

Graduate Attributes (As per NBA)

Engineering Knowledge,Design / development of solutions,Conduct investigations of complex Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/Reference Books:

1	Op-Amps and Linear Integrated Circuits	Ramakant A Gayakwad	Pearson	4thEdition 2015
2	Operational Amplifiers and Linear ICs	David A. Bell	Oxford	3rd Edition 2011
3	Linear Integrated Circuits; Analysis, Design and Applications	B. Somanthan Nair	Wiley India	2013
4	Linear Integrated Circuits	S. Salivahanan, et al	McGraw Hill	2nd Edition,2014
5	Operational Amplifiers and Linear Integrated Circuits	K. Lal Kishore	Pearson	1st Edition, 2012
6	Linear Integrated Circuits	Muhammad H Rashid	Cengage Learning	1st Edition,2014
7	Op-Amps and Linear Integrated Circuits, Concept and Application	James M Fiore	Cengage	2009

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

ELECTRICAL MACHINES LABORATORY -2

Subject Code	15EEL47	IA Marks	20
Number of PracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course Objectives:

- 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. ■

Sl. No	Experiments
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	Swinburne'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 from (i) and (ii).
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 the equivalent circuit of single phase induction motor and determine performance parameters.
12	Conduct an experiment to draw V and Λ curves of synchronous motor at no load and load conditions.

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:

- Test dc machines to determine their characteristics.
- 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.

Graduate Attributes (As per NBA)

Engineering Knowledge, Individual and Team work, Communication.

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(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - IV

OP- AMP AND LINEAR ICS LABORATORY

Subject Code	15EEL48	IA Marks	20
Number of PracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course Objectives:

- To conduct different experiments using OP-Amps
- To conduct experiments using Linear IC's

a)Study of pin details, specifications, application features of IC741 (LM741) and IC555 (Timer) through corresponding datasheets (Datasheets are instruction manuals for electronic components. They explain exactly what a component does and how to use it.).
b)Comparison of output performance quantity of an Operational Amplifier obtained by rigging up the circuit with the ideal value of
(i) A Non – Inverting Amplifier ($V_{out} = AV_{in}$) (ii) An Inverting Amplifier ($V_{out} = -AV_{in}$) (iii) A Difference Amplifier ($V_{out} = -A(V_p - V_n)$) (iv) A Difference Amplifier with floating inputs ($V_{out} = AV_{in}$) (v) A Non – Inverting Amplifier with negative feedback (ii) An Inverting Amplifier with negative feedback (vi) A Differential Amplifier with a negative feedback (vii) A Differential Amplifier with negative feedback and equalised amplifications.
(viii) A Voltage follower (ix) A differential – in differential –out amplifier (x) An instrumentation amplifier
c) Plot of input and output transfer characteristics to analyse and conclude that op-amps are rarely used in open-loop.
d) Testing of op – amp.

To be covered in 03 Laboratory classes.

Sl. No	Experiments
1	Design and verify a precision full wave rectifier. Determine the performance parameters.
2	Design and realize to analyse the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.
3	Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4	Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5	Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.
6	Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.
7	Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.
8	Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.
9	Design and realization of R-2R ladder DAC.
10	Realization of Two bit Flash ADC
11	Design and verify an IC 555 timer based pulse generator for the specified pulse.
12	Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series.

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:

- To conduct experiment to determine the characteristic parameters of OP-Amp
- To design test the OP-Amp as Amplifier, adder, subtractor, differentiator and integrator

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

15EEL48 OP- AMP AND LINEAR ICS LABORATORY (continued)

Course Outcomes (continued):

- To design test the OP-Amp as oscillators and filters
- Design and study of Linear IC's as multivibrator power supplies.

Graduate Attributes (As per NBA)

Engineering Knowledge, Individual and Team work, Communication.

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.

**** END ****

V SEMESTER DETAILED SYLLABUS

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

MANAGEMENT AND ENTREPRENEURSHIP (Core Course)

Subject Code	15EE51	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course objectives:

- To introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- To discuss the ways in which work is allocation, structure of organizations, modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- Toexplaintheroleandimportanceoftheentrepreneurineconomicdevelopmentandtheconceptsof entrepreneurship.
- To explain various types of entrepreneurs and their functions, the myths of entrepreneurship and the factors required for capacity building for entrepreneurs
- To discuss theimportanceofSmallScaleIndustriesandtherelatedtermsandproblemsinvolved.
- To discuss methods for generatingnewbusinessideasandbusinessopportunitiesinIndiaandtheimportance of business plan.
- To introduce the concepts of project management and discuss capitol building process.
- To explain project feasibility study and project appraisal and discuss project financing
- To discuss about different institutions at state and central levels supporting business enterprises. ■

Module-1		**Teaching Hours**
Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession**.** **Planning:** Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2		
Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Versus Decentralization of Authority and Responsibility, Span of Control (Definition only), Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling:** Meaning and Nature of Directing-Leadership Styles, Motivation Theories Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship. ■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE51 MANAGEMENT AND ENTREPRENEURSHIP (Core Course) (continued)

Module-4		**Teaching Hours**
Modern Small Business Enterprises: Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only). **Institutional Support for Business Enterprises:** Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions.■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying.	
Module-5		
Project Management: Meaning of Project, Project Objectives & Characteristics, Project Identification-Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation. New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM **.**■		**10**
Revised Bloom's Taxonomy Level	L_3 – Applying, L_4 – Analysing. L_2 – Understanding, L_4 – Analysing.	

Course outcomes:

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

- Explain the field of management, task of the manager, planning and the need of proper staff, recruitment and selection process.
- Discuss work allocation, the structure of organization, the modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff in exercising the authority and delegating duties.
- To explain the social responsibility of business and leadership
- Explain the concepts of entrepreneurship and the role and importance of the entrepreneur in economic development.
- Show an understanding of the role and importance of Small Scale Industries, business plan and its presentation.
- Discuss the concepts of project management, capitol building process, project feasibility study, project appraisal and project financing.
- Discuss the state /central level institutions / agencies supporting business enterprises.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Life-Long Learning, Accomplishment of Complex Problems.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – V				
15EE51 MANAGEMENT AND ENTREPRENEURSHIP (Core Course) (continued)				
Textbooks				
1	Principles of Management	P.C.Tripathi, P.N.Reddy	McGraw Hill,	6th Edition, 2017
2	Entrepreneurship Development And Small Business Enterprises	Poornima M.Charanthimath	Pearson	2nd Edition,2014
Reference Books				
1	Dynamics of Entrepreneurial Development and Management	Vasant Desai	Himalaya Publishing House	2007
2	Essentials of Management: An International, Innovation and Leadership perspective	Harold Koontz, Heinz Weihrich	McGraw Hill	10th Edition 2016

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

MICROCONTROLLER (Core Course)

Subject Code	15EE52	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course objectives:

- 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, arithmetic operations and data conversion. ■

Module-1		**Teaching Hours**
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. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying,L_4 – Analysing, L_5 – Evaluating.	
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. ■		**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 – V

15EE52 MICROCONTROLLER (Core Course) (continued)

Module-5	**Teaching Hours**
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.■	**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:

- Discuss the history of the 8051 and features of other 8051 family members and the internal architecture of the 8051.
- Explains the use of an 8051 assembler, the stack and the flag register, loop, jump, and call instructions.
- Discuss 8051 addressing modes, accessing data and I/O port programming, arithmetic, logic instructions, and programs.
- Develop 8051C programs for time delay, I/O operations, I/O bit manipulation, logic and arithmetic operations, data conversion and data serialization
- Discuss the hardware connection of the 8051 chip, its timers, serial data communication and its interfacing of 8051to the RS232.
- Discuss in detail 8051 interrupts and writing interrupt handler programs.
- Interface 8051 with real-world devices such as LCDs and keyboards, ADC, DAC chips and sensors.
- Interface 8031/51 with external memories, 8255 chip to add ports and relays, opt isolators and motors.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

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

Reference Books

1	The 8051 Microcontroller	Kenneth Ayala	Cengage Learning	3rd 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	1st Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

POWER ELECTRONICS (Core Course)

Subject Code	15EE53	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course 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 imitations.
- 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	**Teaching Hours**
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, Diode Switched *RL* Load, Freewheeling Diodes with Switched RLLoad. **Diode Rectifiers:**Introduction, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with RL Load, Single-Phase Full-Wave Rectifier with a Highly Inductive Load.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing	
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.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing	
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.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing	
Module-4	
Controlled Rectifiers: Introduction, Single-Phase Full Converters, Single-Phase Dual Converters, Three- Phase Full Converters, Three-Phase Dual Converters, **AC Voltage Controllers:** Introduction, Single-Phase Full-Wave Controllers with Resistive Loads, Single-Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers. ■	**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 – V

15EE53 POWER ELECTRONICS (Core Course) (continued)

Module-5		**Teaching Hours**
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.■		**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:

- Explain application area of power electronics, types of power electronic circuits and switches their characteristics and specifications.
- Explain types of power diodes, their characteristics, and the effects of power diodes on RL circuits.
- Explain the techniques for design, operation and analysis of single phase diode rectifier circuits.
- Explain steady state, switching characteristics and gate control requirements of different power transistors and their limitations.
- Discuss different types of Thyristors, their operation, gate characteristics and gate control requirements.
- Explain designing, analysis techniques and characteristics of thyristor controlled rectifiers.
- Discuss the principle of operation of single phase and three phase DC - DC, DC –AC converters and AC voltage controllers.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

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

Reference Books

1	Power Electronics: Converters, Applications and Design	Ned Mohan et al	Wiley	3rd Edition, 2014
2	Power Electronics	Daniel W Hart	McGraw Hill	1st Edition, 2011
3	Elements of Power Electronics	Philip T Krein	Oxford	Indian Edition, 2008

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

SIGNALS AND SYSTEMS (Core Course)

Subject Code	15EE54	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits – 04

Course objectives:

- To discuss arising of signals in different systems.
- To classify the signals and define certain elementary signals.
- To explain basic operations on signals and properties of systems.
- To explain the use of convolution integral and convolution summation in analyzing the response of linear time invariant systems in continuous and discrete time domains.
- To explain the properties of linear time invariant systems in terms of impulse response description.
- To explain determination of response of a given linear time invariant system and to provide a block diagram representation to it.
- To explain Fourier transform representation of continuous time and discrete time non –periodic signals and the properties of Fourier Transforms.
- To explain the applications of Fourier transform representation to study signals and linear time invariant systems.
- To explain the use of Z-transform in the complex exponential representation of discrete time signals and the analysis of systems. ■

Module-1		**Teaching Hours**
Introduction: Definitions of signals and a system, classification of signals, basic operations on signals. Elementary signals viewed as interconnections of operations, properties of systems. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L – 4 Analysing, L_5 – Evaluating.	
Module-2		
Time – Domain Representations For LTI Systems: Convolution, impulse response, properties, solution of differential and difference equations, block diagram representation.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-3		
The Continuous-Time Fourier Transform: Representation of a non -periodic signals: continuous-time Fourier transform (FT), Properties of continuous-time Fourier transform, Applications. Frequency response of LTI systems, Solutions of differential equations■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
Module-4		
The Discrete-Time Fourier Transform: Representations of non-periodic signals: The discrete-time Fourier transform (DTFT), Properties of DTFT and applications. Frequency response of LTI system, Solutions of differential equations.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating..	
Module-5		
Z- Transforms: Introduction, Z-transform, properties of ROC, properties of Z-transforms, inversion of Z-transform methods - power series and partial expansion, Transforms analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to solve difference equations. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE54 SIGNALS AND SYSTEMS (Core Subject) (continued)

Course outcomes:

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

- Classify the signals and systems.
- Explain basic operations on signals and properties of systems.
- Use convolution in both continuous and discrete domain for the analysis of systems given the impulse response of a system.
- Evaluate response of a given linear time invariant system.
- Provide block diagram representation of a linear time invariant system.
- Apply continuous time Fourier transform representation to study signals and linear time invariant systems.
- Apply discrete time Fourier transform representation to study signals and linear time invariant systems. Use Z-transform and properties of Z transform for the analysis of discrete time systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Modern tool usage, Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Signals and Systems	Simon Haykin, Berry Van Veen	Wiley	2nd Edition,2002

Reference Books

2	Fundamentals of Signals and Systems	Michael J. Roberts, Govind K Sharma	McGraw Hill	2nd Edition 2010
3	Signals and Systems	NagoorKani	McGraw Hill	1st Edition 2010
4	Signals and Systems A Primer with MATLAB	Matthew N.O. Sadiku Warsame H. Ali	CRC Press	1st Edition, 2016
5	Signals and Systems	Anand Kumar	PHI	3rd Edition, 2015

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –V

INTRODUCTION TO NUCLEAR POWER (Professional Elective)

Subject Code	15EE551	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To explain the fission process in nuclear materials and how the nuclear reactors work and the basic components of nuclear reactors and their types.
- Explanation about cooling of reactors, features of coolant, different types of coolants used in the reactors and the losses of cooling.
- Discussion on loss of cooling accidents in different reactors.
- Discussion on postulated severe accidents in water cooled reactors and other reactors and cooling of reactor during removal and processing.
- Discussion on cooling and disposing the nuclear waste and prospect of fusion energy in the future.■

Module-1	**Teaching Hours**
The Earth and Nuclear Power: Sources and Resources: Introduction, Earth's Internal Heat Generation, The Earth's Energy Flow, The Fission Process, Thermal Energy Resources. **How Reactors Work:** Introduction, The Fission Process, Basic Components of a Nuclear Reactor, Thermal Reactors, Fast Reactors. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Cooling Reactors: Introduction, General Features of a Reactor Coolant, Principles of Heat Transfer, Gaseous Coolants, Liquid Coolants, Boiling Coolants. **Loss of Cooling:** Introduction, The Electric Kettle, Pressurized-Water Reactor, Boiling-Water Reactor, CANDU Reactor, Gas-Cooled Reactors, Sodium- Cooled Fast Reactor. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Loss-of-Cooling Accidents: Introduction, Incidents in light Water-Cooled Reactors, Heavy Water-Moderated Reactors, Gas-Cooled Reactors, Liquid Metal-Cooled Fast Reactors.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Postulated Severe Accidents Introduction: Introduction, Postulated Severe Accidents in Water-Cooled Reactors, Specific Phenomena relating to Severe Accidents, Severe Accidents in other Reactor Types, Fission Product Dispersion following Containment Failure. **Cooling during Fuel Removal and Processing**: Introduction, Refuelling, Spent Fuel Storage and Transport, Reprocessing Plant. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
Cooling and Disposing of the Waste: Introduction, Classification of Waste Products, Fission Products and Their Biological Significance, Options for Nuclear Waste Disposal, Long-Term Storage and Disposal of Spent Nuclear Fuel, Storage and Disposal of Fission Products from Reprocessing Plants, Disposal of other Materials. **Fusion Energy -Prospect for the Future:** Introduction, The Fusion Process, Confinement, Current Technical Position, Conclusions. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –V

15EE551INTRODUCTION TO NUCLEAR POWER (Professional Elective) (continued)

Course outcomes:

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

- Explain the fission process in nuclear materials, basic components of nuclear reactors, types of nuclear reactors and their working.
- Discuss different types of coolants, their features, and cooling of reactors,
- Discuss loss of cooling accidents in different reactors.
- Discuss postulated severe accidents in reactors and cooling of reactor during removal of spent fuel.
- Discuss cooling and disposing the nuclear waste and prospect of fusion energy in the future.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Design/ Development of Solutions, The Engineer and Society, Environment and Sustainability, Ethics, Project Management and Finance.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Introduction to Nuclear Power	Geoffrey F. Hewitt	Taylor & Francis	1st Edition, 2000

Reference Books

1	Nuclear Reactor Engineering	G.Vaidyanathan	S.Chand	1st Edition, 2013
2	Introduction to Nuclear Engineering	John R Lamarsh Anthony J Baratta	Pearson	3rd Edition, 2016

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

ELECTRICAL ENGINEERING MATERIALS (Professional Elective)

Subject Code	15EE552	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To impart the knowledge of conducting, dielectric, insulating and magnetic materials and their applications.
- To impart the knowledge of superconducting materials and their applications
- To impart the knowledge of plastics and materials for Opto - Electronic devices. ■

Module-1	**Teaching Hours**
Introduction to Electrical and Electronic Materials: Importance of materials, Classification of electrical and electronic materials, Scope of electrical and electronic materials, Requirement of Engineering materials, Operational requirements of electrical and electronic materials, Classification of solids on the basis of energy gap, Products – working principle and materials, Types of engineering materials, Levels of material structure. Spintronics and Spintronic materials, Ferromagnetic semiconductors, Left handed materials. **Conductors:** Conductor materials, Factors affecting conductivity, Thermal conductivity, Heating effect of current, Thermoelectric effect, Seebeck effect, Thomson effect, Wiedemann – Franz law and Lorentz relation, Problems .■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Conductive Materials and Applications: Mechanically processed forms of electrical materials, Types of conducting materials, Low resistivity materials, High resistivity materials, Contact materials, Fusible materials, Filament materials, Carbon as filamentary and brush material, Material for conductors, cables, wires, solder, sheathing and sealing. **Dielectrics:** Introduction to dielectric materials, classification of dielectric materials, Dielectric constant, Dielectric strength and Dielectric loss. Polarization, Mechanisms of polarization, Comparison of different polarization process, Factors affecting polarization, Spontaneous polarization, Behaviour of polarization under impulse and frequency switching, Decay and build-up of polarization under ac field, Complex dielectric constant.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Insulating Materials: Insulating materials and applications – Ceramic, Mica, Porcelain, Glass, Micanite and Glass bonded mica. Polymeric materials – Bakelite, Polyethylene. Natural and synthetic rubber. Paper. Choice of solid insulating material for different applications, Liquid insulating materials – Requirements, Transformer oil, Bubble theory, Aging of mineral insulating oils. Gaseous insulating Materials – Air, Nitrogen, Vacuum. **Magnetic Materials:** Origin of permanent magnetic dipole, Magnetic terminology, Relation between relative permeability and magnetic susceptibility. Classification of magnetic materials, Diamagnetic, Paramagnetism, Ferromagnetism, Antiferromagnetism and the corresponding materials. Ferrimagnetism and ferrites – properties and applications, Soft and hard ferrites. Curie temperature, Laws of magnetic materials. Magnetization curve, Initial and maximum permeability. Hysteresis loop and loss, Eddy current loss. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-4	
Magnetic Materials (continued): Types of magnetic materials, Soft and hard magnetic materials, High energy magnetic materials, Commercial grade soft and hard magnetic materials. **Superconductive Materials:** Concept of superconductors, Meaning of phenomenon of superconductivity, Properties of superconductors, Types of superconductors, Critical magnetic field	**08**

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE552 ELECTRICAL ENGINEERING MATERIALS (Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Superconductive Materials (continued):and critical temperature, Effects of Isotopic mass on critical temperature, Silsbee rule, Depth of penetration and coherence length. Ideal and Hard superconductors, Mechanism of super conduction, London's theory for Type I superconductors, GLAG theory for Type I superconductors, BCS theory, Applications and limitations. Applications of high temperature superconductors, Superconducting solenoids and magnets, MRI for medical diagnostics.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Plastics: Introduction, Thermoplastics, Rubbers, Thermosets, DC and AC properties, Mechanical properties and processing of plastic. **Materials for Opto – Electronic Devices:** Introduction, Optical phenomena, Reflection, Refraction, Transmittivity, Scattering, Optical absorption, Optical properties of non-metals, Optical properties of metals, Optical properties of semiconductors, Optical properties of insulators. Luminescence, Opto – Electronic devices, Photoconductivity, Photoconductive cell.■		**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:

- Discuss electrical and electronics materials, their importance, classification and operational requirement
- Discuss conducting materials used in engineering, their properties and classification.
- Discuss dielectric materials used in engineering, their properties and classification.
- Discuss insulating materials used in engineering, their properties and classification.
- Discuss magnetic materials used in engineering, their properties and classification
- Explain the phenomenon superconductivity, super conducting materials and their application in engineering.
- Explain the plastic and its properties and applications.
- Discuss materials used for Opto electronic devices.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Advanced Electrical and Electronics Materials; Processes and Applications	K.M. Gupta Nishu Gupta	Wiley	First Edition, 2015
Reference Books				
1	Electronic Engineering Materials	R.K. Shukla Archana Singh	McGraw Hill	2012
2	Electrical Properties of Materials	L Solymar et al	Oxford	9th Edition, 2014
3	Electrical Engineering Materials	A.J. Dekker	Pearson	2016
4	Principle of Electronic Materials and Devices	S.O. Kasap	McGraw Hill	3rd Edition 2010

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

ELECTRICAL ESTMATION AND COSTING (Professional Elective)

Subject Code	15EE553	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss the purpose of estimation and costing.
- To discuss market survey, estimates, purchase enquiries, tenders, comparative statement and payment of bills and Indian electricity act and some of the rules.
- To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses.
- To discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
- To discuss different types of service mains and estimation of power circuits.
- To discuss estimation of overhead transmission and distribution system and its components.
  To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation. ■

Module-1	**Teaching Hours**
Principles of Estimation: Introduction to Estimation and Costing, Electrical Schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, LabourConditions, Determination of Cost Material and Labour, Contingencies, Overhead Charges, Profit, Purchase System, Purchase Enquiry and Selection of Appropriate Purchase Mode, Comparative Statement, Purchase Orders, Payment Of Bills, Tender Form, General Idea about IE Rule, Indian Electricity(IE) Act and IE Rules -29,30,45,46,47,50,51,54,55,77 and79.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding.	
Module-2	
Wiring: Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring. Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables **Wiring (continued):** Main Switch and Distribution Board, Conduits and its accessories and Fittings. Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor. **Internal Wiring:** General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the Textbook), Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout. ..■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Service Mains: Introduction, Types, Estimation of Underground and Overhead Service Connections. **Design and Estimation of Power Circuits:** Introduction, Important Considerations Regarding Motor Installation Wiring, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter. ■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Estimation of Overhead Transmission and Distribution Lines: (Review of Line Supports, Conductor Materials, Size of Conductor for Overhead Transmission Line, Types of Insulators)[No Question Shall be Set From the Review Portion]. Cross Arms, Pole Brackets and Clamps, Guys and Stays, Conductors Configuration Spacing and Clearances, Span Lengths, Lightning Arrestors, Phase Plates, Danger Plates, Anti Climbing Devices, Bird Guards, Beads of Jumpers, Muffs, Points to be Considered at the Time of Erection of Overhead Lines, Erection of Supports, Setting of Stays, Fixing of Cross Arms, Fixing of Insulators, Conductor Erection.	**08**

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

15EE553 ELECTRICAL ESTMATION AND COSTING (Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Estimation of Overhead Transmission and Distribution Lines (continued): Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulators, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead Lines, Clearances of Conductor From Ground, Spacing Between Conductors, Important Specifications. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Applying, L_4 – Analysing	
Module-5		
Estimation of Substations: Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, Equipmentfor Substation, Substation Auxiliaries Supply, Substation Earthing.■		**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:

- Explain the purpose of estimation and costing.
- Discuss market survey, estimates, purchase enquiries, preparation of tenders, comparative statements and payment of bills.
- Discuss Indian Electricity act and Indian Electricity rules.
- Discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses.
- Discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
- Discuss types of service mainsand estimation of service mains and power circuits.
- Discuss estimation of overhead transmission and distribution system and its components.
- Discuss main components of a substation, preparation of single line diagram of a substation and earthing of a substation.■

Graduate Attributes (As per NBA)

Engineering Knowledge,

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	A Course in Electrical Installation Estimating and Costing	J. B. Gupta	Katson Books,	9th Edition, 2012

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

SPECIAL ELECTRICAL MACHINES (Professional Elective)

Subject Code	15EE554	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To impart knowledge on the Construction, principle of operation, control and performance of stepping motors.
- To impart knowledge on the Construction, principle of operation, control and performance of switched reluctance motors and permanent magnet brushless D.C. motors.
- To impart knowledge on the Construction, principle of operation and performance of permanent magnet synchronous motors and synchronous reluctance motor.
- To impart knowledge on single phase special machines and servo motors.
- To impart knowledge on Linear electrical machine and permanent magnet axial flux machines.■

Module-1		**Teaching Hours**
Stepper Motor: Introduction, Variable Reluctance Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types of Stepper Motor, Windings in Stepper Motors, Torque Equation, Characteristics of Stepper Motor, Open – loop Control of Stepper Motor, Closed – loop Control of Stepper Motor, Microprocessor – Based Control of Stepper Motor, Applications of Stepper Motor. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Switched Reluctance Motor (SRM): Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque Equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensors, Current Regulators, Microprocessor – Based Control of SRM, Sensorless Control of SRM. **Permanent Magnet DC Motor and Brushless Permanent Magnet DC Motor:** Permanent Magnet DC (PMDC) motor, Brushless Permanent Magnet DC (BLDC) Motors.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-3		
Permanent Magnet Synchronous Motor (PMSM): Construction, Principle of Operation, EMF Equation, Torque Equation, Phasor Diagram, Circle Diagram, Comparison of Conventional and PMSM, Control of PMSM, Applications. **Synchronous Reluctance Motor (SyRM):** Constructional of SyRM, Working, Phasor Diagram and Torque Equation, Control of SyRM, Advantages and Applications. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-4		
Single Phase Special Electrical Machines: AC series Motor, Repulsion Motor, Hysteresis Motor, Single Phase Reluctance Motor, Universal Motor. **Servo Motors:** DC Servo Motors, AC Servo Motors. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Linear Electric Machines: Linear Induction Motor, Linear Synchronous Motor, DC Linear Motor, Linear Reluctance Motor, Linear Levitation Machines. **Permanent Magnet Axial Flux (PMAF) Machines:** Comparison of Permanent Radial and Axial Flux Machines, Construction of PMAF Machines, Armature Windings, torque and EMF Equations of PMAF, Phasor Diagram, Output Equation, Pulsating Torque And its Minimisation, Control and Applications of PMAF. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

15EE554 SPECIAL ELECTRICAL MACHINES (Professional Elective) (continued)

Course outcomes:

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

- Explain the performance and control of stepper motors, and their applications.
- Explain theory of operation and control of switched reluctance motor and permanent magnet brushless D.C. motors.
- Explain theory of operation and control of permanent magnet synchronous motors and synchronous reluctance motor.
- Explain operation of single phase special machines and servo motors.
- Explain operation of linear electrical machine and permanent magnet axial flux machines. ■

Graduate Attributes (As per NBA):

Engineering Knowledge, Problem analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.

Textbook

1	Special Electrical Machines	E.G. Janardanan	PHI	1st Edition 2014.

Reference Books

1	Special Electrical Machines	K Venkataratham	University Press	2009
2	Brushless Permanent Magnet and Reluctance Motor Drives	T J E Miller	Clerendon Press, Oxford	1989
3	Permanent Magnet and Brushless DC Motors	Kenjo T and Nagamori S	Clerendon Press, Oxford	1985
4	Stepping Motors and their Microprocessor Control	KenjoT	Clerendon Press Oxford	1984
5	Switched Reluctance Motor Drives Modeling, Simulation Design and Applications	Krishan R	CRC	2001

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – V

ELECTRONIC COMMUNICATION SYSTEMS(Open Elective)

Subject Code	15EE561	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain elements of communication system, noise and its effects.
- To describe the theory of amplitude, angle, pulse and digital modulation techniques
- To explain principles of radio communication, transmitters and receivers
- To explain basics of Television Broadcasting
- To explain basic principles of radar systems.
- To discuss multiplexing used in broadband communications.
- To explain the basic routing process used for long-distance telephony
- To explain fiber optic technology used for communication and its components and systems and their installation.
- To discuss basics of information theory, coding and data communication.

Module-1		**Teaching Hours**
Introduction to Communication: Elements of a Communication System, Need for Modulation, Electromagnetic Spectrum and Typical Applications, Terminologies in Communication Systems, Basics of Signal Representation and Analysis. **Noise:** External Noise, internal Noise, Noise Calculations, Noise Figure, Noise Temperature. **Amplitude Modulation Techniques:** Elements of Analog Communication, Theory of Amplitude Modulation Techniques, Generation of Amplitude Modulated Signals.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-2		
Angle Modulation Techniques: Theory of Angle Modulation Techniques, Practical Issues in Frequency Modulation, Generation of Frequency Modulation. **Pulse Modulation Techniques:** Introduction, Pulse Analog Modulation Techniques, Pulse Digital Modulation Techniques. **Digital Modulation Techniques:** Introduction, Basic Digital Modulation Schemes, M-ary Digital Modulation Techniques.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Radio Transmitters and Receivers: Introduction lo Radio Communication, Radio Transmitters, Receiver Types, AM Receivers, FM Receivers, Single- and Independent-Sideband Receivers. **Television Broadcasting:** Requirements and Standards, Black-and-White Transmission, Black-and-White Reception, Colour Transmission and Reception.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Radar Systems: Basic Principles, Pulsed Systems, Other Radar Systems. **Broadband Communication Systems:** Multiplexing, Short-and Medium-Haul Systems, Long-Haul Systems, Elements of Long-Distance Telephony.■		**08**
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 – V

15EE561 ELECTRONIC COMMUNICATION SYSTEMS(Open Elective) (continued)

Module-5	**Teaching Hours**
Introduction to Fiber Optic Technology: History of Fiber Optics, Need of Optical Fibers, Introduction to Light, The Optical Fiber and Fiber Cables, Fiber Optic Components and Systems, Installation, Testing, and Repair. **Information Theory, Coding and Data Communication:** Information Theory, Digital Codes, Error Detection and Correction, Fundamentals of Data Communication System, Data Sets and Interconnection Requirements, Network and Control Considerations.■	**08**
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:

- Understand communication systems and its terminologies.
- Explain noise, computation of noise level in communication systems.
- Describe the theory of amplitude, angle, pulse and digital modulation techniques
- Explain principles of radio communication, transmitters and receivers
- Show understanding of the basic TV system and process transmission and reception
- Explain basic principles of radar systems and multiplexing broadband communication systems.
- Show understanding of fiber optic technology.
- Show understanding of information theory, coding and data communication

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Electronic Communication Systems	George Kennedy	McGraw Hill	5th Edition, 2011

Reference Books

1	Electronic Communications Systems: Fundamentals Through Advanced	Wayne Tomasi	Pearson	5th Edition, 2009
2	Communication Systems	V. Chandrasekar	Oxford	1st Edition, 2012
3	Communication Systems	P Ramakrishna Rao	McGraw Hill	1st Edition, 2013

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

PROGRAMMABLE LOGIC CONTROLLERS (Open Elective)

Subject Code	15EE562	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain advantages and disadvantages, main parts and their functions, basic sequence of operation of PLC.
- To describe the hardware components: I/O modules, CPU, memory devices, other support devices and the functions of PLC memory map.
- To describe program scan sequence, the communication of information to the PLC using different languages, internal relay instruction.
- To explain identification of common operating modes found in PLCs, writing and entering the ladder logic programs.
- To define the functions of Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits and Latching Relays.
- To explain conversion of relay schematics into PLC ladder logic programs and writing PLC programs directly from narrative descriptions.
- To explain the functions of PLC counter instructions, applying combinations of counters and timers to control systems.
- To describe the function of selectable timed interrupt and fault routine files and use of temporary end instruction.
- To explain the execution of data transfer instructions, interruption of data transfer and data compare instructions.
- To explain the basic operation of PLC closed-loop control system, various forms of mechanical sequencers and their operations.
- To describe the operation of bit and word shift registers and develop programs that use shift registers.
- To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes. ■

Module-1	**Teaching Hours**
Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs). **Basics of PLC Programming:** Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding,	
Module-2	
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers:** Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding,.	

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

15EE562 PROGRAMMABLE LOGIC CONTROLLERS (Open Elective) (continued)

Module-3		**Teaching Hours**
Programming Counters: Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. **Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding,.	
Module-4		
Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. **Math Instructions:** Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Sequencer and Shift Register Instructions: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations. **Process Control, Network Systems, and SCADA:** Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA). ■		**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:

- Discuss history of PLC, its sequence of operation, advantages and disadvantages, main parts and their functions.
- Describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.
- Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module.
- Convert relay schematics and narrative descriptions into PLC ladder logic programs
- Analyze PLC timer and counter ladder logic programs
- Describe the operation of different program control instructions
- Discuss the execution of data transfer instructions, data compare instructions and the basic operation of PLC closed-loop control system.
- Describe the operation of mechanical sequencers, bit and word shift registers, processes and structure of control systems and communication between the processes.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V				
15EE562 PROGRAMMABLE LOGIC CONTROLLERS (Open Elective) (continued)				
Textbook				
1	Programmable Logic Controllers	Frank D Petruzella	McGraw Hill,	4th Edition, 2011
Reference Book				
1	Programmable Logic Controllers an Engineer's Guide,	E A Parr	Newnes	3rd Edition, 2013
2	Introduction Programmable Logic Controllers	Gary Dunning	Cengage	3rd Edition, 2006

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

RENEWABLE ENERGY RESOURCES(Open Elective)

Subject Code	15EE563	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- To explain sun – earth geometric relationship, Earth – Sun Angles and their Relationships
- To discuss about solar energy reaching the Earth's surface and solar thermal energy applications.
- To discuss types of solar collectors, their configurations and their applications
- To explain the components of a solar cell system, equivalent circuit of a solar cell, its characteristics and applications.
- To discus benefits of hydrogen energy, production of hydrogen energy, storage its advantages and disadvantages.
- To discuss wind turbines, wind resources, site selection for wind turbine
- To discuss geothermal systems, their classification and geothermal based electric power generation
- To discuss waste recovery management systems, advantages and disadvantages
- To discuss biomass production, types of biomass gasifiers, properties of producer gas.
- To discuss biogas, its composition, production, benefits.
- To discuss tidal energy resources, energy availability, power generation.
- To explain motion in the sea wave, power associated with sea wave and energy availability and the devices for harnessing wave energy.
- To discuss principles of ocean thermal energy conversion and production of electricity.■

Module-1	**Teaching Hours**
Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. **Energy from Sun:** Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications. ■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects ofSolar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond. **Solar Cells:** Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic Panels, Applications of Solar Cell Systems.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy. **Wind Energy:** Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. **Geothermal Energy:** Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects.	**08**

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

15EE563 RENEWABLE ENERGY RESOURCES(Open Elective) (continued)

Module-3 (continued)		**Teaching Hours**
Solid waste and Agricultural Refuse: Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Biomass Energy: Biomass Production, Energy Plantation,Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers. **Biogas Energy:** Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics. **Tidal Energy:**Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. **Ocean Thermal Energy:**Introduction,Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages, Disadvantages and Benefits of OTEC. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

Course outcomes:

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

- Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy.
- Discuss energy from sun, energy reaching the Earth's surface and solar thermal energy applications.
- Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications.
- Discus generation of energy from hydrogen, wind, geothermal system, solid waste and agriculture refuse.
- Discuss production of energy from biomass, biogas.
- Discuss tidal energy resources, energy availability and power generation.
- Discuss power generation sea wave energy and ocean thermal energy. ■

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - V				
15EE563 RENEWABLE ENERGY RESOURCES(Open Elective) (continued)				
Textbook				
1	Nonconventional Energy Resources	ShobhNath Singh	Pearson	1st Edition, 2015
Reference Books				
1	Nonconventional Energy Resources	B.H. Khan	McGraw Hill	3rd Edition,
2	Renewable Energy; Power for a sustainable Future	Godfrey Boyle	Oxford	3rd Edition, 2012
3	Renewable Energy Sources: Their Impact on global Warming and Pollution	TasneemAbbasi S.A. Abbasi	PHI	1st Edition, 2011

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

BUSINESS COMMUNICATION (Open Elective)

Subject Code	15EE564	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss analysing audiences, and choose the most effective structure and style for delivering strategically sound written and spoken messages.
- To discuss how to organize the talk, handling audience response.
- To discuss how to communicate with managers, co-workers, customers and suppliers.
- To discuss how engineers can use written and oral skills, computer, graphics and other engineering tools to communicate with other engineers and management.■

Module-1	**Teaching Hours**
Analyse Communication Purpose and Audience: How to Learn, How Engineers Are Persuaded, Speak or Write: Select the Right Communication Channel, Consider Your Communication Purpose and Audience. **Projecting the Image of the Engineering Profession:** Overcome Anxiety, Primary Impact: Nonverbal Body Language, Secondary Impact: Control Vocal Quality, Volume, And Pace, Optimize Presentation Environment. **Presentation Aids: Engineering:** The Real da Vinci Code, Speaking Visually—Guidelines for Using Presentation Aids, Choosing among Options, Creating Visuals with Impact, Delivering with Visuals. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Organize Your Talk: Planning Your Talk, Conducting an Audience Analysis: 39Questions, Organizing Your Talking Seven Easy Stages, Getting Attention and Keeping Interest, Five Minutes Early – Time Management for Your Presentation, Delivering Your Introduction, Presenting Your Conclusion. **Handling Audience Response:** Create the Environment, Handle with C.A.R.E, Deal with Hostile Questions, Deal with Other Types of Questions, Control the Q&A Session, Thinking on Your Feet. **Organizing for Emphasis:** Make our Bottom Line the Top Line, Purpose Statement and Blueprints, Open Long Reports with a Summary, Use More Topic Sentences, Develop Headings, Structure Vertical Lists. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Write As If Talking to Your Engineering Associates: Use Personal Pronouns, Relyon Everyday Words, Use Short Spoken Transitions, Keep Sentences Short, Reach Out to Your Engineering Readers by Asking Questions, 5Whys-ATechnique for Engineering Problem Solving. **Trim Your Expressions:** Introduction, Prune Wordy Expressions, Use Strong Verbs, Cut Doublings and Noun Strings, Eliminate Unnecessary Determiners and Modifiers, Change Phrases into Single Words, Change Unnecessary Clauses into Phrases or Single Words, Avoid Over using "Itis" and "Thereis", Eight Steps for Lean Writing. **Write Actively—Engineering is about Actions:** Active Voice:"Albert Einstein Wrote the Theory of Relativity", How to Recognize the Passive Voice, How to Write Actively – Use Three Cures, Write Passively for Good Reasons Only, Theory of Completed Staff Work. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Every day Engineering Communications -E-Mails, Phone Calls, and Memos: Effective E-mail Writing: Seven Things to Remember, How to Be Productive on the Phone, "Memos Solve Problems".	**08**

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

15EE564 BUSINESS COMMUNICATION (Open Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Visuals for Engineering Presentation - Engineers Think in Pictures: Optimize Slide Layout, Display Engineering Data Effectively, How to Develop Effective Graphics. **Write Winning Grant Proposals:** Know Your Audience, Understand Your Goal and Marketing Strategy, Select the Correct Writing Style, Organize Your Proposal around the FourPs, A Brief Checklist before Submitting Your Proposal. ■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

Module-5		
How to Effectively Prepare Engineering Reports: Writing an Effective Progress Report, Develop Informative Design Reports. **Listening Interactive Communication about Engineering Risk:** Listening – A Forgotten Risk Communication Skill Listening – Harder Than Speaking and Writing, How to Listen to Voice of Customers about Risk, Listen Attentively: Understanding What Drives Perceived Risk, Thirteen Questions about Risk Communication. ■		**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:

- Apply business communication strategies and principles to prepare effective communication for domestic and international business situations.
- Utilize analytical and problem solving skills appropriate to business communication.
- Participate in team activities that lead to the development of collaborative work skills.
- Select appropriate organizational formats and channels used in developing and presenting business messages.
- Compose and revise accurate business documents using computer technology.
- Communicate via electronic mail, Internet, and other technologies.
- Deliver an effective oral business presentation. ■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text Book

1	What Every Engineer Should Know AboutBusinessCommunication	John X. Wang	CRC	2008

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

MICROCONTROLLER LABORATORY - 1

Subject Code	15EEL57	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80

Credits - 02

Course objectives:

- 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 16 bit numbers.
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 decimal to and Decimal to 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	Alphanumerical LCD panel interface.
11	Generate different waveforms: Sine, Square, Triangular, Ramp using DAC interface.
12	External ADC and Temperature control interface.
13	Elevator interface.
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, 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:

- Write assembly language programs for data transfer, arithmetic, Boolean and logical instructions.
- Write ALP for 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.
- Generate different waveforms using DAC interface.
- Work with a small team to carryout experiments using microcontroller concepts and prepare reports that present lab work.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Modern tool usage, Communication.

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

15EEL57 MICROCONTROLLER LABORATORY – 1(continued)

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.■

Learning beyond the syllabus: To acquire a wide variety of skills and to develop society friendly applications mini projects can be practiced by referring to "Microcontroller Based Projects" Second Edition, An EFY (Electronics For You) Enterprise Pvt Ltd, 2013.

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

POWER ELECTRONICS LABORATORY

Subject Code	15EEL58	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80

Credits - 02

Course objectives:

- To conduct experiments on semiconductor devices to obtain their static characteristics.
- To study different methods of triggering the SCR
- To 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.
- To study commutation of SCR. ■

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 and R –L loads.
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	Design of Snubber circuit.

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:

- Obtain static characteristics of semiconductor devices to discuss their performance.
- Trigger the SCR by different methods
- Verify 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.
- Perform commutation of SCR by different methods.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

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.■

****** END ******

VI SEMESTER DETAILED SYLLABUS

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

CONTROL SYSTEMS (Core Subject)

Subject Code	15EE61	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- 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 to 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 analyze stability of a control system using Nyquist plot.
- To discuss stability analysis using Bode plots.
- To determine the controller or compensator configuration and parameter values relative to how it is connected to the controlled process given the design specifications.■

Module-1		**Teaching Hours**
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.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
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 – 2^{nd} order systems only. **Bode plots:** Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin. ■		**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 - VI

15EE61 CONTROL SYSTEMS (Core Subject) (continued)

Module-5	**Teaching Hours**
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.■	**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:

- Discuss the effects of feedback and types of feedback control systems.
- Evaluate the transfer function of a linear time invariant system.
- Evaluate the stability of linear time invariant systems.
- Apply block diagram manipulation and signal flow graph methods to obtain transfer function of systems.
- Demonstrate the knowledge of mathematical modeling of control systems and components
- Determine transient and steady state time response of a simple control system.
- Investigate the performance of a given system in time and frequency domains.
- Discuss stability analysis using Root locus, Bode plots and Nyquist plots.
- Determine the controller or compensator configuration and parameter values relative to how it is connec ted to the controlled process given the design specifications.

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Modern Tool Usage, Life-long Learning.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Control Systems	Anand Kumar	PHI	2nd Edition, 2014

ReferenceBooks

1	Automatic Control Systems	FaridGolnaraghi, Benjamin C. Kuo	Wiley	9th Edition, 2010
2	Control Systems Engineering	Norman S. Nise	Wiley	4th Edition, 2004
3	Modern Control Systems	Richard C Dorf et al	Pearson	11th Edition, 2008
4	Control Systems, Principles and Design	M.Gopal	McGaw Hill	4th Edition, 2012
5	Control Systems Engineering	S. Salivahanan et al	Pearson	1st Edition, 2015

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

POWER SYSTEM ANALYSIS – 1 (Core Subject)

Subject Code	15EE62	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- 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		**Teaching Hours**
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. ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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, Selection of Circuit Breakers.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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, Measurement of sequence Impedance of Synchronous Generator. ■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	
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.■		**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 -VI

15EE62 POWER SYSTEM ANALYSIS – 1 (Core Subject) (continued)

Module-5		**Teaching Hours**
Power System Stability: Introduction, Dynamics of a Synchronous Machine, Power Angle Equation Salient and Non – Salient pole Synchronous Machines, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability. ■		**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:

- Show understanding of per unit system, its advantages and computation.
- Show the concept of one line diagram and its implementation in problems
- Perform short circuit analysis on a synchronous machine and simple power system to select a circuit breaker for the system.
- Evaluate symmetrical components of voltages and currents in un-balanced three phase circuits.
- Explain the concept of sequence impedance and sequence networks of power system components and power system.
- Analyze three phase synchronous machine and simple power systems for different unsymmetrical faults using symmetrical components.
- Discuss the dynamics of synchronous machine, stability and types of stability.
- Discuss equal area criterion for the evaluation of stability of a simple system under different fault conditions. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, The Engineer and Society, Ethics

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1.	Modern Power System	D. P. Kothari	McGraw Hill	4th Edition, 2011

ReferenceBooks

1	Elements of Power System	William D. StevensonJr	McGraw Hill	4th Edition, 1982
2	Power System Analysis and Design	J.Duncan Glover et al	Cengage	4th Edition, 2008
3	Power System Analysis	Hadi Sadat	McGraw Hill	1st Edition, 2002

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

DIGITAL SIGNAL PROCESSING (Core Subject)

Subject Code	15EE63	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To define Discrete Fourier transform and its properties.
- To evaluate DFT of various signals using properties of DFT.
- To explain different linear filtering techniques**.**
- To explain the evaluation of DFT and inverse DFT using fast and efficient algorithms
- To discuss impulse invariant transformation, bilinear transformation techniques and their properties.
- To design infinite impulse response Butterworth digital filters using impulse invariant and bilinear transformation techniques.
- To design infinite impulse response Chebyshev digital filters using impulse invariant and bilinear transformation techniques.
- To discuss direct, cascade, parallel and ladder methods of realizing a digital IIR filter.
- To discuss window functions used for the design of FIR filters.
- To discuss windowing technique of designing FIR filter.
- To discuss frequency sampling technique of designing FIR filter.
- To discuss direct, cascade and linear phase form of realizing a digital FIR filter. ■

Module-1		**Teaching Hours**
Discrete Fourier Transforms: Definitions, properties-linearity, shift, symmetry Properties- circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stock ham's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods**.** ■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering,L_2 – Understanding,L_3 – Applying,L_4 – Analysing. L_5 – Evaluating	
Module-2		
Fast Fourier Transforms Algorithms: Introduction, decimation in time algorithm, first decomposition, number of computations, continuation of decomposition, number of multiplications, computational efficiency, decimation in frequency algorithms, Inverse radix – 2 algorithms.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing. L_5– Evaluating	
Module-3		
Design of IIR Digital Filters: Introduction, impulse invariant transformation, bilinear transformations, All pole analog filters- Butterworth & Chebyshev filters, design of digital Butterworth filter by impulse invariant transformation and bilinear transformation, Frequency transformations. ■		**10**
Revised Bloom's Taxonomy Level	L1- Remembering, L2 – Understanding, L3 – Applying. L4 – Analysing. L5 – Evaluating	
Module-4		
Design of IIR Digital Filters (Continued): Design of digital Chebyshev –type 1filter by impulse invariant transformation and bilinear transformation, Frequency transformations. **Realization of IIR digital systems:** direct form, cascade form and parallel form, Ladder structures for equal degree polynomial.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5– Evaluating	

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

15EE63 DIGITAL SIGNAL PROCESSING (Core Subject) (continued)

Module-5	**Teaching Hours**
Design of FIR Digital Filters: Introduction, windowing, rectangular, modified rectangular. Hamming, Hanning, Blackman window, **design of FIR digital filters by use of windows, Design of FIR digital filters-**frequency sampling techniques. **Realization of FIR systems:** direct form, cascade form, linear phase form■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5– Evaluating	

Course outcomes:

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

- Compute the DFT of various signals using its properties and linear filtering of two sequences.
- Apply fast and efficient algorithms for computing DFT and inverse DFT of a given sequence
- Design infinite impulse response Butterworth digital filters using impulse invariant / bilinear transformation technique.
- Design infinite impulse response Chebyshev digital filters using impulse invariant or bilinear transformation technique.
- Realize a digital IIR filter by direct, cascade, parallel and ladder methods of realization.
- Discuss different window functions and frequency sampling method used for design of FIR filters.
- Design FIR filters by use of window function or by frequency sampling method.
- Realize a digital FIR filter by direct, cascade, and linear phase form. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem analysis, Design/ Development of Solutions, Modern Tool Usage.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Introduction to Digital Signal Processing	Jhonny R. Jhonson	Pearson	1st Edition, 2016

Reference Books

1.	Digital Signal Processing – Principles, Algorithms, and Applications	Jhon G. Proakis Dimitris G. Manolakis	Pearson	4th Edition, 2007.
2.	Digital Signal Processing	A.NagoorKani	McGraw Hill	2nd Edition, 2012
3	Digital Signal Processing	Shaila D. Apte	Wiley	2nd Edition, 2009
4	Digital Signal Processing	Ashok Amberdar	Cengage	1st Edition, 2007
5	Digital Signal Processing	Tarun Kumar Rawat	Oxford	1st Edition, 2015

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

ELECTRICAL MACHINE DESIGN (Core Course)

Subject Code	15EE64	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To discuss design factors, limitations in design and modern trends in design and manufacturing of electrical machines.
- To discuss the properties of electrical, magnetic and insulating materials used in the design of electrical machines.
- To derive the output equation of DC machine, single phase, three phase transformers, induction motor and synchronous machines.
- To discuss the selection of specific loadings, for various machines.
- To discuss separation of main dimensions for different electrical machines
- To discuss design of field windings for DC machines and synchronous machines.
- To evaluate the performance parameters of transformer, induction motor.
- To design of cooling tubes for the transformer for a given temperature rise.
- To explain design of rotor of squirrel cage rotor and slip ring rotor.
- To define short circuit ratio and discuss its effect on machine performance.■

Module-1	**Teaching Hours**
Fundamental Aspects of Electrical Machine Design: Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques. **Electrical Engineering Materials:** Desirabilities of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2	
Design of DC Machines: Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Design of Transformers: Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.■	**10**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Design of Three Phase Induction Motors: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.■	**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 -VI

15EE64 ELECTRICAL MACHINE DESIGN (Core Course) (continued)

Module-5

Design of Three Phase Synchronous Machines: Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding.■	**10**
Revised Bloom's Taxonomy Level L_3 – Applying, L_4 – Analysing. L_2 – Understanding, L_4 – Analysing.	

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

- Discuss design factors, limitations, modern trends in design, manufacturing of electrical machines and properties of materials used in the electrical machines.
- Derive the output equations of transformer, DC machines and AC machines.
- Discuss selection of specific loadings and magnetic circuits of different electrical machines
- Design the field windings of DC machine and Synchronous machine.
- Design stator and rotor circuits of a DC and AC machines.
- Estimate the number of cooling tubes, no load current and leakage reactance of core type transformer.
- Discuss short circuit ratio and its effects on performance of synchronous machines.
- Design salient pole and non-salient pole alternators for given specifications. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics

.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	A course in Electrical Machine design	A.K.Sawhney	DhanpatRai	6th Edition, 2013

Reference Books

1	Performance and Design of Alternating Current Machines	M.G. Say	CBS Publisher	3rd Edition, 2002
2	Design Data Handbook	A. Sanmugasundaram Et al	New Age International	1st Edition, 2011

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

COMPUTER AIDED ELECTRICAL DRAWING (Professional Elective)

Subject Code	15EE651	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- 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	**Teaching Hours**
Winding Diagrams: (a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings. (b) Developed Winding Diagrams of A.C. Machines: (c)Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings. (d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3 Tier Windings. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

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. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	
Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Alternator – Sectional Views of Stator and Rotor dealt separately. ■	**08**
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 - VI

15EE651 COMPUTER AIDED ELECTRICAL DRAWING (Professional Elective) (continued)

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

- Discuss the terminology and types of DC and AC armature windings.
- Develop armature winding diagram for DC and AC machines
- Develop a layout for substation using the standard symbols for substation equipment. .
- Draw sectional views of core and shell types transformers using the design data
- Draw sectional views of assembled DC machine or its parts using the design data or the sketches.
- Draw sectional views of assembled alternator or its parts using the design data or the sketches.■

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis,Modern tool usage,Ethics.

Question paper pattern:

- The question paper will have two parts, PART – A and PART – B.
- Each part is for 40 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	6th Edition, 2013
2	Electrical Engineering Drawing	K. L. Narang	SatyaPrakashan	2014

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

ADVANCED POWER ELECTRONICS (Professional Elective)

Subject Code	15EE652	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To study switching mode regulators and Boost converters, Resonant Pulse Inverters and multilevel inverters
- To learn the techniques for design and analysis of dc –dc converters, Resonant Pulse Inverters and multilevel inverters
- To explain the operation and frequency characteristics of resonant inverters and the techniques for zero-voltage and zero-current switching
- To study the performance parameters of resonant inverters
- To explain the techniques for analyzing and design of resonant inverters
- To explain the operation and features of multilevel inverters, their advantages and disadvantages.
- To explain the control strategy to address capacitor voltage unbalancing.
- To discuss potential applications of multilevel inverters.
- To study the types and circuit topologies of power supplies and explain the operation and analysis of power supplies.
- To study the applications of power electronic devices.■

Module-1		**Teaching Hours**
DC–DC Converters: Switching-Mode Regulators, Comparison of Regulators, Multi-output Boost Converter, Diode Rectifier-Fed Boost Converter, Averaging Models of Converters, State–Space Analysis of Regulators, Design Considerations for Input Filter and Converters, Drive IC for Converters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2		
Resonant Pulse Inverters: Introduction. Series Resonant Inverters, Frequency Response of Series Inverters, Parallel Resonant Inverters, Voltage Controlled Resonant Inverters, Class E Resonant Inverter, Class E Resonant Rectifier, Zero – Current Switching (ZCS) Resonant Converters, Zero Voltage Switching Resonant Converters (ZVS), Comparison between ZCS and ZVS Resonant Converters, Two Quadrant ZVS Resonant Converters, Resonant DC – Link Inverters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-3		
Multilevel Inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters, Diode – Clamped Multilevel Inverter, Flying - Capacitors Multilevel Inverter. Cascaded Multilevel Inverter, Applications, Features of Multilevel Inverters, Comparison of Multilevel Converters.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-4		
Power Supplies: Introduction, DC Power Supplies, AC Power Supplies, Multistage Conversions, Control Circuits, Magnetic Design Considerations.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_4 – Analysing	

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

15EE652 ADVANCED POWER ELECTRONICS (Professional Elective) (continued)

Module-5	**Teaching Hours**
Residential and Industrial Applications: Introduction, Residential Applications, Industrial Applications. **Electrical Utility Applications:** Introduction, High Voltage DC Transmission, Static VAR Compensators, Interconnection of Renewable Energy Sources and Energy Storage systems to the Utility Grid, Active Filters.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding. L_4 – Analysing	

Course outcomes:

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

- Explain the types of switching – mode regulators, Resonant Pulse Inverters and multilevel inverters
- To discuss the techniques for design and analysis of dc –dc converters, Resonant Pulse Inverters and multilevel inverters
- Evaluate the performance parameters of resonant inverters
- Explain the techniques for zero-voltage and zero-current switching of resonant pulse inverters
- Explain the control strategy to address capacitor voltage unbalancing in multilevel inverters.
- Discuss the types, topologies operation and analysis of power supplies.
- Discuss residential, Industrial and Electrical utility applications of power electronic devices. ■■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis Design/ Development of Solutions , Conduct investigations of complex problems, Ethics

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Power Electronics: Circuits Devices and Applications,	Mohammad H Rashid	Pearson	4th Edition, 2014
2	Power Electronics Converters, Applications and Design (For Module 5: Chapters 16 and 17)	Ned Mohan et al	Wiley	3rd Edition, 2014

Reference Books

1	Power Electronics	Daniel W Hart	McGraw Hill	1st Edition, 2011

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

ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (Professional Elective)

Subject Code	15EE653	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain the importance of energy audit, its types and energy audit methodology.
- To explain the parameters required for energy audit and the working of the instruments used in the measurement of the parameters.
- To explain the energy audit of different systems and equipment and buildings
- To explain electrical load management techniques, harmonics and their effects, electricity tariffs and power factor improvement.
- To explain the scope of demand side management, its concept and implementation issues and strategies.
- To discuss energy conservation ■

Module-1		**Teaching Hours**
Energy Scenarios: Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism. **Types of Energy Audits and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training. **Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis.■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing.	
Module-2		
Energy Audit of Boilers: Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods. **Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency.■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing ,	
Module-3		
Energy Audit of HVAC Systems: Introduction to HVAC, Components of Air – Conditioning System, Types of Air – Conditioning Systems, Human Comfort Zone and Psychrometry, Vapour – Compression Refrigeration Cycle, Energy Use Indices, Impact of Refrigerants on Environment and Global Warming, Energy – Saving Measures in HVAC, Star Rating and Labelling by BEE. **Electrical-Load Management:** Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses.■		**08**
Revised Bloom's Taxonomy Level	L_1 - Remembering, L_2 - Understanding, L_3 - Applying, L_4 - Analysing	
Module-4		
Energy Audit of Motors: Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling. **Energy Audit of Lighting Systems:**Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. ■		**08**
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 -VI

15EE653 ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (Professional Elective)(continued)

Module-5	**Teaching Hours**
Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings. **Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment. **Energy Conservation:** Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation.■	**08**
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:

- Understand the need of energy audit and energy audit methodology.
- Explain audit parameters and working principles of measuring instruments used to measure the parameters.
- Conduct energy audit of boilers, furnaces, power plant, steam distribution system and compressed air systems.
- Conduct energy audit HVAC systems, motors, pumps, blowers and cooling towers.
- Explain load management techniques, effects of harmonics, electricity tariff, improvement of power factor and losses in transmission.
- Conduct energy audit of lighting systems and buildings.
- Show an understanding of demand side management and energy conservation.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex Problems, Environment and sustainability, Ethics, Individual and Team work, Communication

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Handbook on Energy Audit	Sonal Desai	McGraw Hill	1st Edition, 2015
2.	Generation of Electrical Energy	B R Gupta	S. Chand	1stEdition, 1983

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER –VI

SOLAR AND WIND ENERGY (Professional Elective)

Subject Code	15EE654	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To discuss the importance of energy in human life, relationship among economy and environment with energy use.
- To discuss the increasing role of renewable energy, energy management, energy audit, energy efficiency, energy intensity.
- To discuss energy consumption status in India, energy saving potential and energy conservation efforts in India.
- To explain the concept of energy storage and the principles of energy storage devices.
- To discuss the characteristics and distribution of solar radiation, measurement of components of solar radiation and analysis of collected solar radiation data.
- To explain availability of solar radiation at a location and the effect of tilting the surface of collector with respect to horizontal surface.
- To describe the process of harnessing solar energy in the form of heat and working of solar collectors.
- To discuss applications of solar energy including heating and cooling.
- To discuss the operation of solar cell and the environmental effects on electrical characteristics of solar cell
- To discuss sizing and design of typical solar PV systems and their applications.
- To discuss basic Principles of Wind Energy Conversion and to compute the power available in the wind.
- To discuss forces on the Blades, Wind Energy Conversion, collection of Wind Data, energy estimation and site selection.
- To discuss classification of WEC Systems, its advantages and disadvantages of WECS, and Types of Wind Machines (Wind Energy Collectors).
- To evaluate the performance of Wind-machines, Generating Systems.
- To discuss energy storage, applications of Wind Energy and Environmental Aspects.■

Module-1		**Teaching Hours**
Fundamentals of Energy Science and Technology: Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non -conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India. **Energy Conservation and Efficiency:** Introduction, Important Terms and Definitions, Important Aspects of Energy Conservation, Global Efforts, Achievements and Future Planning, Energy Conservation/Efficiency Scenario in India, Energy Audit, Energy Conservation Opportunities. **Energy Storage:** Introduction, Necessity of Energy Storage, Specifications of Energy Storage Devices. **Solar Energy-Basic Concepts:** Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extraterrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Solar Energy-Basic Concepts (continued): Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface. **Solar Thermal Systems:** Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers.■		**08**
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 – VI

15EE654 SOLAR AND WIND ENERGY (Professional Elective) (continued)

Module-3		**Teaching Hours**
Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario – World and India. The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations **Wind energy systems:** Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5		
Basic Components of a Wind Energy Conversion(WEC) System: Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind-machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

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

- Discuss the importance of energy in human life, relationship among economy and environment with energy use and the increasing role of renewable energy.
- Explain the concept of energy storage and the principles of energy storage devices.
- To discuss solar radiation on horizontal and tilted surface, its characteristics, measurement and analysis of radiation data.
- Describe the process of harnessing solar energy and its applications in heating and cooling.
- Discuss fabrication, operation of solar cell, electrical characteristics, sizing and design of solar PV systems and their applications.
- Explain basic Principles of Wind Energy Conversion, collection of wind data, energy estimation and site selection.
- Discuss the performance of Wind-machines, energy storage, applications of Wind Energy and environmental aspects.■

Graduate Attributes (As per NBA)
Engineering Knowledge, Design/ Development of Solutions, The Engineer and Society, Environment and Sustainability, Ethics, Project Management and Finance.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER – VI				
15EE654 SOLAR AND WIND ENERGY(Professional Elective) (continued)				
Textbook				
1	Non-Conventional Energy Resources	B. H. Khan	McGraw Hill	2nd Edition 2017
2	Non-Conventional Sources of Energy	Rai, G. D	Khanna Publishers	4th Edition, 2009
Reference Books				
1	Non-Conventional Energy Resources	ShobhNath Singh	Pearson	1st Edition, 2015
2	Solar Energy – Principles of Thermal Collections and Storage	S.P. Sukhatme J.K.Nayak	McGraw Hill	3rd Edition, 2008
3	Wind Turbine Technology	Ahmad Hemami	Cengage	1st Edition, 2012

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

ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC (Open Elective)

Subject Code	15EE661	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback networks.
- To teach about the concept of fuzziness involved in various systems.
- To provide adequate knowledge about fuzzy set theory. ■

Module-1	**Teaching Hours**
Fundamentals of Neural Networks: Basic concepts of Neural networks, Human Brain, Model of an Artificial Neuron, Neural network architectures, Characteristics of Neural Networks, Learning methods, Taxonomy of Neural Network Architectures, Early Neural Network Architectures. **Back propagation Networks**: Architecture of a Back propagation network, the Perceptron Model, The solution, Single layer Artificial Neural Network, Model for Multilayer Perceptron, Back propagation Learning, Illustration, Applications.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Back propagation Networks (continued): Effect of Tuning Parameters of the Back propagation Neural Network, Selection of Various Parameters in BPN, Variations of Standard Back propagation Algorithm. **Associative Memory:** Auto correlators, Hetero correlators: Kosko's Discrete BAM, Wang et al.'s Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real-coded Pattern Pairs, Applications, Recent Trends. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3	
Adaptive Resonance Theory: Introduction, ART l, ART 2, Applications, Sensitivities of Ordering of Data.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-4	
Fuzzy Set Theory: Fuzzy versus Crisp, Crisp sets, Fuzzy Sets, Crisp Relations, FuzzyRelations. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding. L_3 – Applying.	
Module-5	
Fuzzy Logic And Inference: Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Rule based System, Defuzzification Methods, Applications. **Type – 2 Fuzzy Sets**: Representation of Type – 2 Fuzzy Sets, Operations on Type – 2 Fuzzy Sets, Interval Type – 2 Fuzzy Sets.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding. L_3 – Applying.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI

15EE661 ARTIFICIAL NEURAL NETWORKS & FUZZY LOGIC (Open Elective) (continued)

Course outcomes:

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

- Show an understanding of Organization of the Brain, Biological and Artificial Neuron Models
- Show an understanding of Back propagation network architecture, Perceptron Model, Single layer Artificial Neural Network, Model for Multilayer Perceptron, Back propagation Learning,
- Show an understanding of Back propagation training and summary of Back propagation Algorithm
- Show an understanding Bidirectional Associative Memory (BAM) Architecture
- Show an understanding adaptive resonance theory architecture and its applications
- Differentiate between crisp logic, predicate logic and fuzzy logic.
- Explain fuzzy rule based system
- Show an understanding of Defuzzification methods. ■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications.	S. Rajasekaran, G.A. VijayalakshmiPai	PHI Learning	2nd Edition, 2017

Reference Books

1	Neural Networks – A comprehensive foundation	Simon Haykin	Prentice Hall	3rd Edition, 2004.
2	Fuzzy Logic With Engineering Applications	Timothy J Ross	Wiley	3rd Edition, 2014
3.	Fuzzy sets and Fuzzy Logic: Theory and Applications	Klir, G.J. Yuan Bo	Prentice Hall	2005.

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI

SENSORS AND TRANSDUCERS(Open Elective)

Subject Code	15EE662	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits – 03

Course objectives:

- To discuss need of transducers, their classification, advantages and disadvantages.
- To discuss working of different types of transducers and sensors..
- To discuss recent trends in sensor technology and their selection.
- To discuss basics of signal conditioning and signal conditioning equipment.
- To discuss configuration of Data Acquisition System and data conversion.
- To discuss the basics of Data transmission and telemetry.
- To explain measurement of various non-electrical quantities.■

Module-1	**Teaching Hours**
Sensors and Transducers: Introduction, Classification of Transducers**,** Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Sensors and Transducers (continued): Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-3	
Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. **Data Acquisition Systems and Conversion:**Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-4	
Data Transmission and Telemetry: Data/Signal Transmission, Telemetry. **Measurement of Non – Electrical Quantities:**Pressure Measurement■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-5	
Measurement of Non – Electrical Quantities (continued): Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Metes, Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER – VI

15EE662 SENSORS AND TRANSDUCERS(Open Elective) (continued)

Course outcomes:

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

- Discuss need of transducers, their classification, advantages and disadvantages.
- Show an understanding of working of various transducers and sensors.
- Discuss recent trends in sensor technology and their selection.
- Discuss basics of signal conditioning and signal conditioning equipment.
- Discuss configuration of Data Acquisition System and data conversion.
- Show knowledge of data transmission and telemetry.
- Explain measurement of non-electrical quantities -temperature, flow, speed, force, torque, power and viscosity.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Electrical and Electronic Measurements and instrumentation	R.K Rajput	S. Chand	3rd Edition, 2013.

Reference Books

1	A Course in Electronics and Electrical Measurements and Instruments	J.B. Gupta	Katson Books	13th Edition, 2008
2	A Course in Electrical and Electronic Measurements and Instrumentation	A. K. Sawheny	DhanpatRai	2015

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

BATTERIES AND FUEL CELLS FOR COMMERCIAL, MILITARY AND SPACE APPLICATIONS
(Open Elective)

Subject Code	15EE663	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss the current status of various rechargeable batteries and fuel cells for various applications.
- To discuss the performance capabilities and limitations of batteries and fuel cells.
- To discuss the performance requirements for next-generation high-power rechargeable lithium-based batteries and sealed nickel-cadmium and lead-acid batteries.
- To discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW)
- To describe the high-power batteries currently used by EVs and HEVs and various next-generation rechargeable batteries best suited for all-electric cars, EVs, and HEVs.
- To discuss low-power battery configurations that are best suited for compact commercial, industrial, and medical applications.
- To identify the design aspects and performance characteristics of micro- and nano-batteries best suited for detection, sensing, and monitoring devices. ■

Module-1	**Teaching Hours**
Current Status of Rechargeable Batteries and Fuel Cells: Rechargeable Batteries, Fundamental Aspects of a Rechargeable Battery, Rechargeable Batteries Irrespective of Power Capability, Rechargeable Batteries for Commercial and Military Applications, Batteries for Low-Power Applications, Fuel Cells. ■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Batteries for Aerospace and Communications Satellites: Introduction, On-board Electrical Power System, Battery Power Requirements and Associated Critical Components, Cost-Effective Design Criterion for Battery-Type Power Systems for Spacecraft, Spacecraft Power System Reliability, Ideal Batteries for Aerospace and Communications Satellites, Performance Capabilities and Battery Power Requirements for the Latest Commercial and Military Satellite Systems, Military Satellites for Communications, Surveillance, Reconnaissance, and Target Tracking, Batteries Best Suited to Power Satellite Communications Satellites.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Fuel Cell Technology: Introduction, Performance Capabilities of Fuel Cells Based on Electrolytes, Low-Temperature Fuel Cells Using Various Electrolytes, Fuel Cells Using a Combination of Fuels, Fuel Cell Designs for Multiple Applications, Ion-Exchange Membrane Fuel Cells, Potential Applications of Fuel Cells, Fuel Cells for Aircraft Applications, Fuel Cells for Commercial, Military, and Space Applications, Fuel Cells Capable of Operating in Ultra-High-Temperature Environments, Fuel Cell Requirements for Electric Power Plant Applications.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Batteries for Electric and Hybrid Vehicles: Introduction, Chronological Development History of Early Electric Vehicles and Their Performance Parameters, Electric and Hybrid Electric Vehicles	**08**

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

15EE663 BATTERIES & FUEL CELLS FOR COMMERCIAL, MILITARY & SPACE APPLICATIONS(Open Elective) (continued)

Module-4(continued)		**Teaching Hours**
Batteries for Electric and Hybrid Vehicles (continued): Developed Earlier by Various Companies and Their Performance Specifications, Development History of the Latest Electric and Hybrid Electric Vehicle Types and Their Performance Capabilities and Limitations, Performance Requirements of Various Rechargeable Batteries, Materials for Rechargeable Batteries, Critical Role of Rare Earth Materials in the Development of EVs and HEVs.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Low-Power Rechargeable Batteries for Commercial, Space, and Medical Applications: Introduction, Low-Power Battery Configurations, Characteristics, Batteries for Miniaturized Electronic System Applications, for Embedded-System Applications, Batteries for Medical Applications, Selection Criteria for Primary and Secondary (Rechargeable) Batteries for Specific Applications. ■		**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:

- Discuss the current status, the performance capabilities and limitations of rechargeable batteries and fuel cells for various applications.
- To discuss the performance requirements for next-generation high-power rechargeable lithium-based batteries and sealed nickel-cadmium and lead-acid batteries.
- Discuss fuel cells that are best suited for applications where electrical power requirements vary between several kilowatts (kW) to a few megawatts (MW)
- Describe the high-power batteries currently used by EVs and HEVs and various next-generation rechargeable batteries best suited for all-electric cars, EVs, and HEVs.
- Discuss low-power battery configurations that are best suited for compact commercial, industrial, and medical applications.
- Explain the design aspects and performance characteristics of micro- and nano-batteries best suited for detection, sensing, and monitoring devices.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Next-Generation Batteries and Fuel Cells for Commercial, Military, and Space Applications	A.R. JHA	CRC Press	1st Edition, 2012

Reference Books

1	Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors.	Vladimir S. Bagotsky	John Wiley	1st Edition,2015
2	Modelling and Control of Fuel Cells: Distributed Generation Applications	M. HashemNehrir Caisheng Wang	Wiley	1st Edition,2009

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

INDUSTRIAL SERVO CONTROL SYSTEMS(Professional Elective)

Subject Code	15EE664	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- To discuss system analogs and vectors, with a review of differential equations.
- To discuss the concept of transfer functions for the representation of differential equations.
- To discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- To determine the frequency response techniques for proper servo compensation.
- To explain perform indices and performance criteria for servo systems.
- To discuss the mechanical considerations of servo systems.■

Module-1		**Teaching Hours**
Servos: Introduction, Benefits of Servo Systems, Types of Servos - Evolution of Servo Drives, Classification of Drives, Components of Servos - Hydraulic/Electric Circuit Equations,Actuators—Electric,Actuators—Hydraulic,Amplifiers—Electric,Amplifiers—Hydraulic,Transducers (Feedback).■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Machine Servo Drives: Types of Drives, Feed Drive Performance. **Troubleshooting Techniques:** Techniques by Drive, Problems: Their Causes and Cures. **Machine Feed Drives:** Advances in Technology, Parameters for making ApplicationChoices. **Application of Industrial Servo Drives:** Introduction ,Physical System Analogs, Quantities and Vectors,Differential Equations for PhysicalSystems,Electric Servo Motor TransferFunctions and Time Constants, Transport Lag Transfer Function,Hydraulic Servo Motor Characteristics,General Transfer Characteristics.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Generalized Control Theory: Servo Block Diagrams,Frequency-Response Characteristics and Construction of Approximate (Bode) Frequency Charts,Nichols Charts, Servo Analysis Techniques,Servo Compensation. **Indexes of Performance:** Definition of Indexes of Performance for Servo Drives,Indexes of Performance for Electric and Hydraulic Drives.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Performance Criteria: Percent Regulation,Servo System Responses. **Servo Plant CompensationTechniques:** Dead-Zone Nonlinearity,Change-in-Gain Nonlinearity,Structural Resonances,Frequency Selective Feedback,Feedforward Control. **Machine Considerations:**Machine feed drive Considerations,Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

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

15EE664 INDUSTRIAL SERVO CONTROL SYSTEMS (Open Elective) (continued)

Module-5		**Teaching Hours**
Machine Considerations: Drive Stiffness, Drive Resolution,Drive Acceleration,Drive Speed Considerations,Drive Ratio Considerations,Drive Thrust/Torque And FrictionConsiderations, Drive Duty Cycles.■		**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:

- Explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
- Discuss system analogs and vectors, with a review of differential equations.
- Discuss the concept of transfer functions for the representation of differential equations.
- Discuss mathematical equations for electric servo motors, both DC and brushless DC servo motors.
- Represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
- Determine the frequency response techniques for proper servo compensation.
- Explain perform indices and performance criteria for servo systems.
- Discuss the mechanical considerations of servo systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text Book

1	Industrial Servo Control SystemsFundamentals andApplications	George W. Younkin	Marcel Dekker	1st Edition, 2003

Reference Books

1	Servo Motors and Industrial Control Theory	RiazollahFiroozian	Springer	2nd Edition, 2014
2	DC SERVOS Application and Design with MATLAB	Stephen M. Tobin	CRC	1st Edition, 2011

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

CONTROL SYSTEM LABORATORY

Subject Code	15EEL67	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80

Credits - 02

Course objectives:

- To determine the time and frequency domain reposes of a given second order system using software package or discrete components.
- To design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
- To draw the performance characteristics of ac and dc servomotors and synchro-transmitter receiver pair.
- To 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.
- To write a script files to plot root locus, bode plot, Nyquist plots to study the stability of the system using a software package.■

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. (b) To determine experimentally the transfer function of the lead compensating network.
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.
	Experiments 7 to 11 must be done using MATLAB/SCILAB only.
7	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of additional poles and zeros on time response of second order system. (c) To evaluate the effect of pole location on stability (d) To evaluate the effect of loop gain of a negative feedback system on stability.
8	To simulate a second order system and study the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
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) To estimate the effect of open loop gain on the transient response of closed loop system using root locus. (c) Comparative study of Bode, Nyquist and root locus with respect to stability.
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.

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

15EEL67 CONTROL SYSTEM LABORATORY(continued)

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

- Use software package or discrete components in assessing the time and frequency domain reposes of a given second order system.
- Design and analyze Lead, Lag and Lag – Lead 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.
- Write a script files to plot root locus, bode plot, Nyquist plots to study the stability of the system using a software package.
- Work with a small team to carryout experiments and prepare reports that present lab work. ■

Graduate Attributes (As per NBA)

Engineering Knowledge,Problem Analysis, Individual and Team work, Modern tool usage, Communication.

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(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VI

DIGITAL SIGNAL PROCESSING LABORATORY

Subject Code	15EEL68	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80

Credits - 02

Course objectives:

- To explain the use of MATLAB software in evaluating the DFT and IDFT of given sequence
- To verify the convolution property of the DFT
- To 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) the matrix method and (c) Linear convolution from circular convolution with zero padding.
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

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding. L_3 – Applying, L_4 – Analysing, L_5 – Evaluating,

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

- Give 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 experiments using software and prepare reports that present lab work■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

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.■

****** END ******

VII SEMESTER DETAILED SYLLABUS

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

POWER SYSTEM ANALYSIS – 2(Core Course)

Subject Code	15EE71	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To explain formulation of network models and bus admittance matrix for solving load flow problems.
- To discuss solution of nonlinear static load flow equations by different numerical techniques and methods to control voltage profile.
- To discuss optimal operation of generators on a bus bar, optimal unit commitment, reliability considerations and optimum generation scheduling.
- To discuss optimal power flow solution, scheduling of hydro-thermal system, power system security and reliability.
- 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		**Teaching Hours**
Load Flow Studies: Introduction, Network Model Formulation, Formation of Y_{bus} by Singular Transformation, Load Flow Problem, Gauss-Seidel Method.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-2		
Load Flow Studies (continued): Newton-Raphson Method, Decoupled Load Flow Methods, Comparison of Load Flow Methods, Control of Voltage Profile.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-3		
Optimal System Operation: Introduction, Optimal Operation of Generators on a Bus Bar, Optimal Unit Commitment, Reliability Considerations, Optimum Generation Scheduling.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-4		
Optimal System Operation (continued): Optimal Load Flow Solution, Optimal Scheduling of Hydrothermal System, Power System Security, Maintenance Scheduling, Power System Reliability.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying L_4 – Analysing.	
Module-5		
SymmetricalFault Analysis: Algorithm for Short Circuit Studies, Z_{bus} Formulation. **Power System Stability:**Numerical Solution of Swing Equation, Multimachine Stability.■		**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:

- Formulate network matrices and models for solving load flow problems.
- Perform steady state power flow analysis of power systems using numerical iterative techniques.
- Suggest a method to control voltage profile.
- Show knowledge of optimal operation of generators on a bus bar, optimal unit commitment,

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)
15EE71POWER SYSTEM ANALYSIS – 2(Core Subject) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

Course outcomes(continued):

- Discuss optimal scheduling for hydro-thermal system, power system security and reliability.
- Analyze short circuit faults in power system networks using bus impedance matrix.
- Perform numerical solution of swing equation for multi-machine stability■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Modern Power System Analysis	D. P. Kothari	McGraw Hill	4th Edition, 2011

Reference Books

1	Computer Methods in Power Systems Analysis	Glenn W Stagg Ahmed H Ei - Abiad	McGraw Hill	1stEdition, 1968
2	Computer Techniques in Power System Analysis	M.A. Pai	McGraw Hill	2ndEdition, 2006
3	Power System Analysis	HadiSaadat	McGraw Hill	2ndEdition, 2002

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

POWER SYSTEM PROTECTION(Core Subject)

Subject Code	15EE72	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To discuss performance of protective relays, components of protection scheme and relay terminology.
- To explain relay construction and operating principles.
- To explain Overcurrent protection using electromagnetic and static relays and Overcurrent 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 Overvoltages and Gas Insulated Substation (GIS). ■

Module-1		**Teaching Hours**
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.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.■		**10**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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.■		**10**
Revised Bloom's Taxonomy Level	L_2 – Understanding, L_3 – Applying, L_4 – Analysing, L_5 – Evaluating.	

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

15EE72 POWER SYSTEM PROTECTION (Core Course) (continued)

Module-4	**Teaching Hours**
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.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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).■	**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:

- Discuss performance of protective relays, components of protection scheme and relay terminology overcurrent protection.
- Explain the working of distance relays and the effects ofarc resistance, power swings, line length and source impedance on performance of distance relays.
- Discuss pilot protection; wire pilot relaying and carrier pilot relaying.
- Discuss construction, operating principles and performance of differential relays for differential protection.
- Discuss protection of generators, motors, Transformer and Bus Zone Protection.
- Explain the principle of circuit interruption in different types of circuit breakers.
- Describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.
- Discuss protection against Overvoltages and Gas Insulated Substation (GIS).■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics, Communication, Life-long Learning.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbook

1	Power System Protection and Switchgear	Badri Ram, D.N. Vishwakarma	McGraw Hill	2nd Edition
2	Power System Protection and Switchgear(For additional study on gapless arrester, Refer to pages 458 to 461)	BhuvaneshOza et al	McGraw Hill	1st Edition, 2010

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII				
15EE72 POWER SYSTEM PROTECTION (Core Course) (continued)				
Reference Books				
1	Protection and Switchgear	Bhavesh et al	Oxford	1st Edition, 2011
2	Power System Switchgear and Protection	N. Veerappan S.R. Krishnamurthy	S. Chand	1st Edition, 2009
3	Fundamentals of Power System Protection	Y.G.Paithankar S.R. Bhide	PHI	1st Edition, 2009

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

HIGH VOLTAGE ENGINEERING (Core Course)

Subject Code	15EE73	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- To discuss conduction and breakdown in gases, liquid dielectrics.
- To discuss breakdown in solid dielectrics.
- To discuss generation of high voltages and currents and their measurement.
- To discuss overvoltage phenomenon and insulation coordination in electric power systems.
- To discuss non-destructive testing of materials and electric apparatus.
- To discuss high-voltage testing of electric apparatus■

Module-1	**Teaching Hours**
Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges. **Conduction and Breakdown in Liquid Dielectrics:**Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids. **Breakdown in Solid Dielectrics:** Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding.	
Module-2	
Generation of High Voltages and Currents: Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents, Tripping and Control of Impulse Generators.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering , L_2 – Understanding L_3 – Applying.	
Module-3	
Measurement of High Voltages and Currents: Measurement of High Direct Current Voltages, Measurement of High AC and Impulse Voltages, Measurement of High Currents – Direct, Alternating and Impulse, Cathode Ray Oscillographs for Impulse Voltage and Current Measurements.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering , L_2 – Understanding L_3 – Applying.	
Module-4	
Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems: National Causes for Overvoltages - Lightning Phenomenon, Overvoltage due to Switching Surges, System Faults and Other Abnormal, Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding.	
Module-5	
Non-Destructive Testing of Materials and Electrical Apparatus: Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements.	**10**

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

15EE73 HIGH VOLTAGE ENGINEERING (Core Course) (continued)

Module-5 (continued)	**Teaching Hours**
High Voltage Testing of Electrical Apparatus: Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers, Testing of Surge Arrestors, Radio Interference Measurements, Testing of HVDC Valves and Equipment.■	
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:

- Explain conduction and breakdown phenomenon in gases, liquid dielectrics.
- Explain breakdown phenomenon in solid dielectrics.
- Explain generation of high voltages and currents
- Discuss measurement techniques for high voltages and currents.
- Discuss overvoltage phenomenon and insulation coordination in electric power systems.
- Discuss non-destructive testing of materials and electric apparatus andhigh-voltage testing of electric apparatus■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	High Voltage Engineering	M.S. Naidu, V.Kamaraju	McGraw Hill	5th Edition, 2013.

Reference Books

1	High Voltage Engineering Fundamentals	E. Kuffel, W.S. Zaengl, J. Kuffel	Newnes	2nd Edition, 2000
2	High Voltage Engineering	Wadhwa C.L.	New Age International	3rd Edition, 2012
3	High-Voltage Test and Measuring Techniques	Wolfgang Hauschild • Eberhard Lemke	Springer	1st Edition2014
4	High Voltage Engineering	Farouk A.M. Rizk	CRC Press	1st Edition2014

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

ADVANCED CONTROL SYSTEMS(Professional Elective)

Subject Code	15EE741	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To introduce state variable approach for linear time invariant systems in both the continuous and discrete time systems
- To explain development of state models for linear continuous – time and discrete – time systems
- To explain application of vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems
- To define controllability and observability of a system and testing techniques for controllability and observability of a given system
- To explain design techniques of pole assignment and state observer using state feedback.
- To explain about inherent and intentional nonlinearities that can occur in control system and developing the describing function for the nonlinearities.
- To explain stability analysis of nonlinear systems using describing function analysis.
- To explain the analysis of nonlinear systems using Lyapunov function and design of Lyapunov function for stable systems.■

Module-1		**Teaching Hours**
State Variable Analysis and Design: Introduction, Concept of State, State Variables and State Model, State Modelsfor Linear Continuous – Time Systems, State Variables and Linear Discrete – Time Systems.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-2		
State Variable Analysis and Design (continued): Diagonalization, Solution of State Equations, Concepts of Controllability and Observability. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-3		
Pole Placement Design and State Observers: Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement, State Regulator Design, Design of State Observer, Compensator Design by the Separation Principle. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-4		
Non-linear systems Analysis: Introduction, Common Nonlinear System Behaviours, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-5		
Non-linear systems Analysis (continued): Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	

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

15EE741 ADVANCED CONTROL SYSTEMS(Professional Elective) (continued)

Course outcomes:

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

- Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.
- Develop of state models for linear continuous – time and discrete – time systems.
- Apply vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.
- Define controllability and observability of a system and test for controllability and observability of a given system.
- Design pole assignment and state observer using state feedback.
- Develop the describing function for the nonlinearity present to assess the stability of the system.
- Develop Lyapunov function for the stability analysis of nonlinear systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.

Textbook

1	Control Systems Engineering (For the Modules 1 and 2)	I.J. Nagarath and M.Gopal	New Age	5th Edition, 2007
2	Digital Control and State Variable Methods: Conventional and Intelligent Control Systems (For the Modules 3,4 and 5)	M.Gopal	McGraw Hill	3rdEdition, 2008

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

UTILIZATION OF ELECTRICAL POWER(Professional Elective)

Subject Code	15EE742	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- 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	**Teaching Hours**
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.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
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.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
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	**08**

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

15EE742 UTILIZATION OF ELECTRICAL POWER(Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
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.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

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. ■		**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:

- Discuss electric heating, air-conditioning and electric welding.
- Explain laws of electrolysis, extraction and refining of metals and electro deposition.
- Explain the terminology of illumination, laws of illumination, construction and working of electric lamps.
- Design interior and exterior lighting systems- illumination levels for factory lighting- flood lighting- street lighting.
- Discuss systems of electric traction, speed time curves and mechanics of train movement.
- Explain the motors used for electric traction and their control.
- Discuss braking of electric motors, traction systems and power supply and other traction systems.
- Explain the working of electric and hybrid electric vehicles. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, The Engineer and Society, Ethics, Individual and Team Work.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	A Textbook on Power System Engineering	A. Chakrabarti et al	DhanpatRai and Co	2nd Edition, 2010
2	Modern Electric,Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design (Chapters 04 and 05 for module 5)	MehrdadEhsani et al	CRC Press	1stEdition, 2005

Reference Books

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

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

CARBON CAPTURE AND STORAGE(Professional Elective)

Subject Code	15EE743	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To provide an overview of carbon capture and carbon storage and explain the fundamentals of power generation.
- To explain carbon capture from power generation, industrial processes, using solvent absorption and other technologies including membranes, adsorbents, chemical looping, cryogenics and gas hydrate technology.
- To explain different geological storage methods including storage in coal seams, depleted gas reservoirs and saline formations.
- To explain Carbon dioxide compression and pipeline transport.■

Module-1	**Teaching Hours**
Introduction: The Carbon Cycle, Mitigating Growth of The Atmospheric Carbon Inventory, The Process of Technology Innovation. **Overview of carbon capture and storage:** Carbon Capture, Carbon Storage. **Power generation fundamentals:** Physical and Chemical Fundamentals, Fossil-Fueled Power Plant, Combined Cycle Power Generation, Future Developments in Power-Generation Technology.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Carbon capture from power generation: Introduction, Pre-combustion Capture, Post-combustion Capture, Oxy- fuel Combustion Capture, Chemical Looping Capture Systems, Capture-Ready and Retrofit Power Plant, Approaches to Zero-Emission Power Generation. **Carbon capture from industrial processes:**Cement Production, Steel Production, Oil Refining, Natural Gas Processing. **Absorption capture systems:**Chemical and Physical Fundamentals, Absorption Applications in Post Combustion Capture, Absorption Technology RD&D Status.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Adsorption capture systems: Physical and Chemical Fundamentals, Adsorption Process Applications, Adsorption Technology RD&D Status. References and Resources. **Membrane separation systems:**Physical and Chemical Fundamentals, Membrane Configuration and Preparation and Module Construction, Membrane Technology RD&D Status, Membrane Applications in Pre-combustion Capture, Membrane and Molecular Sieve Applications in Oxy-fuel Combustion, Membrane Applications in Post-combustion CO_2 Separation, Membrane Applications in Natural Gas Processing.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Cryogenic and distillation systems: Physical Fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan–Holmes process for CO_2 – CH_4 separation, RD&D in cryogenic and distillation technologies. **Mineral carbonation:** Physical and chemical fundamentals, Current state of technology development, Demonstration and deployment outlook. **Geological storage:** Introduction, Geological and engineering fundamentals, Enhanced oil recovery, Saline aquifer storage, Other geological storage options.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	

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

15EE743 CARBON CAPTURE AND STORAGE(Professional Elective) (continued)

Module-5	**Teaching Hours**
Ocean storage: Introduction, Physical, chemical, and biological fundamentals, Direct CO_2 injection, Chemical sequestration, Biological sequestration, **Storage in terrestrial ecosystems:** Introduction, Biological and chemical fundamentals, Terrestrial carbon storage options, Full GHG accounting for terrestrial storage, Current R&D focus in terrestrial storage. **Other sequestration and use options:** Enhanced industrial usage, Algal biofuel production.■	**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:

- Discuss the impacts of climate change and the measures that can be taken to reduce emissions.
- Discuss carbon capture and carbon storage.
- Explain the fundamentals of power generation.
- Explain methods of carbon capture from power generation and industrial processes.
- Explain different carbon storage methods: storage in coal seams, depleted gas reservoirs and saline formations.
- Explain Carbon dioxide compression and pipeline transport. ■

Graduate Attributes (As per NBA)

Engineering Knowledge

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Carbon Capture and Storage	Stephen A. Rackley	Elsevier	2010

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

POWER SYSTEM PLANNING (Professional Elective)

Subject Code	15EE744	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss primary components of power system planning namely load furcating, evaluation of energy resources, provisions of electricity Act and Energy Conservation Act.
- To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution
- To explain forecasting of anticipated future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- To discuss methods to mobilize resources to meet the investment requirement for the power sector
- To perform economic appraisal to allocate the resources efficiently and take proper investment decisions
- To discuss expansion of power generation and planning for system energy in the country
- To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions
- To discuss principles of distribution planning, supply rules, network development and the system studies
- To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.
- To discuss grid reliability, voltage disturbances and their remedies.
- To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity.
- To discuss market principles and the norms framed by CERC for online trading and exchange in the interstate power market. ■

Module-1	**Teaching Hours**
Power System: Power Systems, Planning Principles, Planning Process, Project Planning, Power Development, Power Growth, National and Regional Planning, Enterprise Resources Planning, Structure of a Power System, Power Resources, Planning Tools, Power Planning Organisation, Regulation, Scenario Planning. **Electricity Forecasting:** Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Power-System Economics: Financial Planning, Techno – Economic Viability, Private Participation, Financial Analysis, Economic Analysis, Economic Characteristics – Generation Units, Transmission, Rural Electrification Investment, Total System Analysis, Credit - Risk Assessment, Optimum Investment, Tariffs. **Generation Expansion:** Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies. ■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Generation Expansion (continued): Distributed Power Generation, Renovation and Modernisation of Power Plants. **Transmission Planning:** Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-4	
Distribution: Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity,	**08**

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

15EE744 POWER SYSTEM PLANNING (Professional Elective) (continued)

Module-4(continued)		**Teaching Hours**
Distribution(continued): Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification, Villages Self – Sufficiency in Energy, Community Power, Self – Generation. **Reliability and Quality:** Reliability Models, System Reliability, Reliability and Quality Planning, Functional Zones, Generation Reliability Planning Criteria, Transmission Reliability Criteria, Distribution Reliability, Reliability Evaluation, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Quality of Supply, Reliability and Quality Roadmap.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Demand-Side Planning: Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit. **Electricity Market:** Market Principles, Power Pool, Independent System Operator, Distribution System Operator, Power Balancing, Market Participants, Power Markets, Market Rules, Bidding, Trading, Settlement System, Locational Marginal Pricing, Transmission Charges, Merchant Power, Differential Electricity, Congestion Management, Ancillary Services, Hedging, Smart Power Market.■		**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:

- Discuss primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution.
- Show knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.
- Discuss methods to mobilize resources to meet the investment requirement for the power sector
- Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions
- Discuss expansion of power generation and planning for system energy in the country, evaluation of operating states of transmission system, their associated contingencies and the stability of the system.
- Discuss principles of distribution planning, supply rules, network development and the system studies
- Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies
- Discuss planning and implementation of electric –utility activities, market principles and the norms framed by CERC for online trading and exchange in the interstate power market.■

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, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Electric Power Planning	A. S. Pabla	McGraw Hill,	2nd Edition, 2016

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

FACTS AND HVDC TRANSMISSION (Professional Elective)

Subject Code	15EE751	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- To explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- To describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- To describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- To explain advantages of HVDC power transmission, overview and organization of HVDC system.
- To describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions.■

Module-1		**Teaching Hours**
FACTS Concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What Limits the Loading Capability? Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitions of FACTS Controllers, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability. Methods of Controllable Var Generation –Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC).Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches. Static VAR Compensators: SVC and STATCOM, the Regulation Slope. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Static Series Compensators: Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator, Transmitted Power Versus Transmission AngleCharacteristic.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Development of HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. **Power Conversion:**3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	

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

15EE751 FACTS AND HVDC TRANSMISSION (Professional Elective) (continued)

Module-5	**Teaching Hours**
Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.■	**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:

- Discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- Describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.
- Explain advantages of HVDC power transmission, overview and organization of HVDC system.
- Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbooks

1	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems	Narain G Hingorani, Laszlo Gyugyi	Wiley	1st Edition, 2000
2	HVDC Transmission: Power Conversion Applicationsin Power Systems	Chan-Ki Kim et al	Wiley	1st Edition, 2009

Reference Books

1	Thyristor Based FACTS Controllers for Electrical Transmission Systems	R. Mohan Mathur, Rajiv K. Varma	Wiley	1st Edition, 2002

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

TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS(Professional Elective)

Subject Code	15EE752	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- Describe the process to plan, control and implement commissioning of electrical equipment's.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Identification of tools and equipment's used for installation and maintenance of electrical equipment.
- Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgears.■

Module-1	**Teaching Hours**
Electrical Tools, accessories: Tools, Accessories and Instruments required for Installation, Maintenance and Repair Work, India Electricity Rules, Safely Codes Causes and Prevention of Accidents, Artificial Respiration, Workmen's Safety Devices. **Transformers:** Installation, Location Site Selection, Foundation Details, Code of Practice for Terminal Plates, Polarity and Phase Sequence, Oil Tanks, Drying of Winding sand General Inspection. Commissioning Tests As Per National and International Standards - Volts Ratio Earth Resistance, Oil Strength, Insulation Tests, Impulse Tests Polarizing Index, Load Temperature Rise Tests. Specific Tests for Determination of Performance Curves like Efficiencies, Regulation Etc., Determination Mechanical Stress Under Normal and Abnormal Conditions.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding.	
Module-2	
Synchronous Machines: Specifications as per BIS Standards. Installation - Physical Inspection, Foundation Details, Alignments, Excitation Systems, Cooling and Control Gear, Drying Out. Commissioning Tests - Insulation, Resistance Measurement of Armature and Field Windings, Wave Form and Telephone Interference Tests, Line Charging Capacitance. Performance Tests -Various Tests to Estimate the Performance of Generator Operations, Slip Test, Maximum Lagging Current, Maximum Reluctance Power Tests, Sudden Short Circuit Tests, Transient Sub Transient Parameters, Measurement of Sequence Impedances, Capacitive Reactance, and Separation Of Losses, Temperature Rise Test, and Retardation Tests. Factory Tests -Gap Length, Magnetic Eccentricity, Balancing Vibrations, Bearing Performance.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-3	
Induction Motor: Specifications. Installation- Location of Motors and its Control Apparatus, Shaft Alignment for Various Coupling, Fitting of Pulleys and Coupling, Drying of Windings. Commissioning Tests -Mechanical Tests For Alignment, Air Gap Symmetry, Tests for Bearings, Vibrations and Balancing. Specific Tests -Performance and Temperature Raise Tests, Stray Load Losses, Shaft Alignment, Re-Writing and Special Duty Capability, Site Test■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	
Module-4	
Laying of Underground Cables: Inspection, Storage, Transportation and Handling of Cables, Cable Handing Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning. Location of Faults using Megger, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System, Causes and Dim, and Flickering Lights■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.	

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

15EE752 TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS
(Professional Elective) (continued)

Module-5	**Teaching Hours**
Switchgear and Protective Devices: Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests. **Domestic Installation:** Introduction, Testing of Electrical Installation of a Building, Testing of Insulation Resistance to Earth, Testing of Insulation and Resistance between Conductors Continuity or Open Circuit Test, Short Circuit Test, Testing of Earthing Continuity, Location of Faults, IE Rules for Domestic Installation■	**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 –Analysing, L_5 –Evaluating.

Course outcomes:

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

- Describe the process to plan, control and implement commissioning of electrical equipment's.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Describe corrective and preventive maintenance of electrical equipment's.
- Explain the operation of an electrical equipment's such as isolators, circuit breakers, induction motor and synchronous machines.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Text/ Reference Books

1	Testing, Commissioning, Operation and Maintenance of Electrical Equipment	S. Rao	Khanna Publishers	6th Edition, 19th Reprint, 2015
2	Testing and Commissioning of Electrical Equipment	R.L.Chakrasali	Prism Books Pvt Ltd	1st Edition,2014
3	Preventive Maintenance of Electrical Apparatus	S.K.Sharotri	Katson Publishing House	1st Edition, 1980
4	Handbook of Switchgears	BHEL	McGraw Hill	1st Edition, 2005
5	Transformers	BHEL	McGraw Hill	1st Edition, 2003
6	TheJ&P Transformer Book	Martin J. Heathcote	Newnes	12th Edition, 1998

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

SPACECRAFT POWER TECHNOLOGIES(Professional Elective)

Subject Code	15EE753	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.
- To discuss near – earth environmental factors that will affect the design of space craft power systems.
- To describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.
- To discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.
- To discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.
- To describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations. ■

Module-1		**Teaching Hours**
Spacecraft: Introduction, the Beginnings, the Electrical Power System. **Environmental Factors:** Introduction, Orbital Considerations, The Near-earth Space Environment. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-2		
Solar Energy Conversion: Introduction, Solar Cell Fundamentals, Space Solar Cell Calibration and Performance Measurements, Silicon Space Solar Cells, III-V Compound Semiconductor Solar Cells, Thin Film Solar Cells. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Solar Energy Conversion (continued): Space Solar Cell Arrays, Space Thermo photovoltaic Power Systems. **Chemical Storage and Generation Systems:** Introduction, Inventions, Evolution of Batteries in Space, Fundamentals of Electrochemistry, Cell and Battery Mechanical Design, Performance Metrics. ■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Chemical Storage and Generation Systems (continued): Electrochemical Cell Types, Fuel Cell Systems.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Power Management and Distribution (PMAD): Introduction, Functions of PMAD, Components and Packaging, System Examples. ■		**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:

- Discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.
- Discuss near – earth environmental factors that will affect the design of space craft power systems.

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

15EE753 SPACECRAFT POWER TECHNOLOGIES(Professional Elective)(continued)

Course outcomes(continued):

- Describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.
- Discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.
- Discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.
- Describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Spacecraft Power Technologies	A.K. Hyder et al	Imperial College Press	1st Edition, 2000

Reference Books

1	Spacecraft Power Systems	Mukund R. Patel	CRC Press	1st Edition, 2004

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

INDUSTRIAL HEATING (Professional Elective)

Subject Code	15EE754	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain construction, classification of industrial furnaces and the methods of heat transfer in them
- To discuss heating capacity of batch furnaces
- To discuss heating capacity of continuous furnaces
- To discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.
- To explain operation and control of industrial furnaces.■

Module-1	**Teaching Hours**
Industrial Heating Processes: Industrial Process Heating Furnaces, Classifications of Furnaces, Elements of Furnace Construction. **Heat Transfer in Industrial Furnaces:** Heat Required for Load and Furnace, Flow of Heat Within the Charged Load, Heat Transfer to the Charged Load Surface, Determining Furnace Gas Exit Temperature, Thermal Interaction in Furnaces, Temperature Uniformity, Turndown.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Heating Capacity of Batch Furnaces: Definition of Heating Capacity, Effect of Rate of Heat Liberation, Effect of Rate of Heat Absorption by the Load, Effect of Load Arrangement, Effect of Load Thickness, Vertical Heating, Batch Indirect-Fired Furnaces, Batch Furnace Heating Capacity Practice, Controlled Cooling in or After Batch Furnaces.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Heating Capacity of Continuous Furnaces: Continuous Furnaces Compared to Batch Furnaces, Continuous Dryers, Ovens, and Furnaces for <1400 F (<760 C), Continuous Midrange Furnaces, 1200 to 1800 F (650 to 980 C), Sintering and Pelletizing Furnaces, Axial Continuous Furnaces for Above 2000 F (1260 C), Continuous Furnaces for 1900 to 2500 F (1038 to 1370 C), Continuous Liquid Heating Furnaces.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4	
Saving Energy in Industrial Furnace Systems: Furnace Efficiency, Methods for Saving Heat, Heat Distribution in a Furnace, Furnace, Kiln, and Oven Heat Losses, Heat Saving in Direct-Fired Low-Temperature Ovens, Saving Fuel in Batch Furnaces, Saving Fuel in Continuous Furnaces, Effect of Load Thickness on Fuel Economy, Saving Fuel in Reheat Furnaces, Fuel Consumption Calculation, Fuel Consumption Data for Various Furnace Types, Energy Conservation by Heat Recovery from Flue Gases, Energy Costs of Pollution Control.■	**08**
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-5	**08**
Operation and Control of Industrial Furnaces: Burner and Flame Types, Location, Flame Fitting, Unwanted NOx Formation, Controls and Sensors- Care, Location, Zones, Air/Fuel Ratio Control, Furnace Pressure Control Turndown Ratio, Furnace Control Data Needs, Soaking Pit Heating Control, Uniformity Control in Forge Furnaces, Continuous Reheat Furnace Control. ■	
Revised Bloom's Taxonomy Level: L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	

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

15EE754 INDUSTRIAL HEATING (Professional Elective) (continued)

Course outcomes:

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

- Explain construction, classification of industrial furnaces
- Discuss the methods of heat transfer in industrial furnaces.
- Discuss heating capacity of batch furnaces and continuous furnaces
- Discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.
- Explain operation and control of industrial furnaces.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Industrial Furnaces	W. Trinks	Wiley	6th Edition, 2004

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

POWER SYSTEM SIMULATION LABORATORY

Subject Code	15EEL76	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course objectives:

- To explain the use of MATLAB package to assess the performance of medium and long transmission lines.
- To explain the use of MATLAB package to obtain the power angle characteristics of salient and non-salient pole alternator.
- To explain the use of MATLAB package to study transient stability of radial power systems under three phase fault conditions.
- To explain the use of MATLAB package to develop admittance and impedance matrices of interconnected power systems.
- To explain the use of Mi-Power package to solve power flow problem for simple power systems.
- To explain the use of Mi-Power package to perform fault studies for simple radial power systems.
- To explain the use of Mi-Power package to study optimal generation scheduling problems for thermal power plants. ■

Sl. No		Experiments
1	Use of MATLAB package	Formation for symmetric π /T configuration for Verification of $AD - BC = 1$, 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 Transformation and Inspection Method.
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 (Bus) Profile.
7	Use of Mi-Power package	Formation of Jacobian for a System not Exceeding 4 Buses (No PV Buses) in Polar Coordinates.
8		Load Flow Analysis using Gauss Siedel Method, NR Method and Fast Decoupled Method for Both PQand PV Buses.
9		To Determine Fault Currents and Voltages in a Single Transmission Line System with Star-Delta Transformers at a Specified Location for LG and LLG faults by simulation.
10		Optimal Generation Scheduling for Thermal power plants by simulation.

Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, 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:

- Develop a program in MATLAB to assess the performance of medium and long transmission lines.
- Develop a program in MATLAB to obtain the power angle characteristics of salient and non-salient pole alternator.
- Develop a program in MATLAB to assess the transient stability under three phase fault at different locations in a of radial power systems.
- Develop programs in MATLAB to formulate bus admittance and bus impedance matrices of interconnected power systems.
- Use Mi-Power package to solve power flow problem for simple power systems.
- Use Mi-Power package to study unsymmetrical faults at different locations in radial power systems
- Use of Mi-Power package to study optimal generation scheduling problems for thermal power plants. ■

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

15EEL76POWER SYSTEM SIMULATION LABORATORY (continued)

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

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(EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER -VII

RELY AND HIGH VOLTAGE LABORATORY

Subject Code	15EEL77	IA Marks	20
Number ofPracticalHours/Week	03	Exam Hours	03
Total Number of PracticalHours	42	Exam Marks	80

Credits - 02

Course objectives:

- 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 sparkover characteristics for both uniform and non-uniform configurations using High AC and DC voltages.
- To measure high AC and DC voltages
- To 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. The experiments under Part – D is compulsory.		
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 Relay.
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, Point – Point and Plane – 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/ Transmission Line/ Sphere Gap.
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.
Revised Bloom's Taxonomy Level		L_3 – Applying, L_4 – Analysing, L_5 – Evaluating, L_6 – Creating

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

15EEL77 RELY AND HIGH VOLTAGE LABORATORY (continued)

Course outcomes:

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

- Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays both electromagnetic and static type.
- Experimentally 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 AC 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. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

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 (EEE)
CHOICE BASED CREDIT SYSTEM (CBCS)
SEMESTER - VII

PROJECT PHASE – I AND SEMINAR

Subject Code	15EEP78	IA Marks	100
Number ofPracticalHours/Week	--	Exam Hours	--
Total Number of PracticalHours	--	Exam Marks	--

Credits - 02

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- 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 Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the 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:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.

Continuous Internal Evaluation

CIE marks for the project report (50 marks)and seminar (50 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. ■

****** END ******

VIII SEMESTER DETAILED SYLLABUS

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

POWER SYSTEM OPERATION AND CONTROL(Core Course)

Subject Code	15EE81	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course 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 define unit commitment and explain various constraints in unit commitment and the solution methods
- To explain issues of hydrothermal scheduling and solutions to hydro thermal problems
- 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	**Teaching Hours**
Introduction: Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centres. **Supervisory Control and Data acquisition (SCADA):** Introduction to SCADA and its Components, Standard SCADA Configurations, Users of Power Systems SCADA, Remote Terminal Unit for Power System SCADA, Common Communication Channels for SCADA in Power Systems, Challenges for Implementation of SCADA. **Unit Commitment:** Introduction, SimpleEnumeration Constraints, Priority List Method, DynamicProgramming Method for Unit Commitment.■	**10**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_4 – Analysing.	
Module-2	
Hydro-thermal Scheduling: Introduction, Scheduling Hydro Systems, Discrete Time Interval Method, Short Term Hydro Thermal Scheduling Using $\gamma - \lambda$ Iterations, Short Term Hydro Thermal Scheduling Using Penalty Factors. **Automatic Generation Control (AGC):** Introductions, Basic Generator Control Loops, Commonly used Terms in AGC, Functions of AGC, Speed Governors.■	**10**
Revised Bloom's Taxonomy Level L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Automatic Generation Control (continued): Mathematical Model of Automatic Load Frequency Control, AGC Controller, Proportional Integral Controller. **Automatic Generation Control in interconnected Power system:** Introductions, Tie - Line Control with Primary Speed Control, Frequency Bias Tie - Line Control, State-Space Models.■	**10**
Revised Bloom's Taxonomy Level L_3 – Applying.	
Module-4	
Automatic Generation Control in interconnected Power system (continued): State-Space Model for Two - Area System, Tie-Line Oscillations, Related Issues in Implementation of AGC. **Voltage and Reactive Power Control:** Introduction, Production and Absorption of Reactive Power, Methods of Voltage Control, Dependence of Voltage on Reactive Power , Sensitivity of Voltage to Changes in P And Q, Cost Saving, Methods of Voltage Control by Reactive Power Injection, Voltage Control Using Transformers, Voltage Stability. ■	**10**
Revised Bloom's Taxonomy Level L_3 – Applying.	

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

15EE81POWER SYSTEM OPERATION AND CONTROL(Core Course) (continued)

Module-5	**Teaching Hours**
Power System Reliability and Security: Introduction, Security Levels of System, Reliability Cost, Adequacy Indices, Functions of System Security, Contingency Analysis, Linear Sensitivity Factors, Contingency Selection and Ranking. **State estimation of Power Systems:** Introduction, Linear Least Square Estimation, DC State Estimator, Other Issues in State Estimation.■	**10**
Revised Bloom's Taxonomy Level L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	

Course outcomes:

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

- Describe various levels of controls in power systems, the vulnerability of the system,components, architecture and configuration of SCADA.
- Solve unit commitment problems
- Explain issues of hydrothermal scheduling and solutions to hydro thermal problems
- Explain basic generator control loops, functions of Automatic generation control, speed governors
- Develop and analyze mathematical models of Automatic Load Frequency Control
- Explain automatic generation control, voltage and reactive power control in an interconnected power system.
- Explain reliability, security, contingency analysis, state estimation and related issues of power systems.■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Communication, Life-long Learning.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Power System Operation and Control	K. Uma Rao	Wiley	1st Edition, 2012

Reference Books

1	Power Generation Operation and Control	Allen J Wood etal	Wiley	2nd Edition,2003
2	Power System Stability and Control	Kundur	McGraw Hill	8th Reprint, 2009

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

INDUSTRIAL DRIVES AND APPLICATIONS(Core Course)

Subject Code	15EE82	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

Credits - 04

Course objectives:

- 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

15EE82 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, Machine Tools. ■	**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:

- Explain the advantages and choice of electric drive.
- 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 different conditions.
- Control induction motor, synchronous motor and stepper motor drives.
- Suggest a suitable electrical drive for specific application in the industry. ■

Graduate Attributes (As per NBA)

Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage.

Question paper pattern:

- 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.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook

1	Fundamentals of Electrical Drives	Gopal K. Dubey	Narosa Publishing House	2nd Edition, 2001
2	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives under module 5.)	VedumSubrahmanyam	McGraw Hill	2nd Edition, 2011

Reference Books

1	Electric Drives	N.K De,P.K. Sen	PHI Learning	1st Edition, 2009

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

SMART GRID(Professional Elective)

Subject Code	15EE831	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To define smart grid and discuss the progress made by different stakeholders in the design and development of smart grid.
- To explain the measurement techniques using PMUs and smart meters.
- To discuss tools for the analysis of smart grid and design, operation and performance.
- To discuss incorporating performance tools such as voltage and angle stability and state estimation into smart grid.
- To discuss classical optimization techniques and computational methods for smart grid design, planning and operation.
- To discuss the development of predictive grid management and control technology for enhancing the smart grid performance.
- To discuss development of cleaner, more environmentally responsible technologies for the electric system.
- To discuss the fundamental tools and techniques essential to the design of the smart grid.
- To describe methods to promote smart grid awareness and enhancement.
- To discuss methods to make the existing transmission system smarter by investing in new technology.■

Module-1	**Teaching Hours**
Smart Grid Architectural Designs: Introduction, Today's Grid versus the Smart Grid, Energy Independence and Security Act of 2007: Rationale for the Smart Grid, Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Working Definition of the Smart Grid Based on Performance Measures, Representative Architecture, Functions of Smart Grid Components. **Smart Grid Communications and Measurement Technology:** Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Microgrid and Smart Grid Comparison. **Performance Analysis Tools for Smart Grid Design:** Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, DSOPF Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingencies and Their Classification, Contingency Studies for the Smart Grid.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Stability Analysis Tools for Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Computational Tools for Smart Grid Design: Introduction to Computational Tools, Decision Support Tools, Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto	**08**

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

15EE831 SMART GRID(Professional Elective) (continued)

Module-3 (continued)		**Teaching Hours**
Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges. **Pathway for Designing Smart Grid:** Introduction to Smart Grid Pathway Design, Barriers and Solutions to Smart Grid Development, Solution Pathways for Designing Smart Grid Using Advanced Optimization and Control Techniques for Selection Functions, General Level Automation, Bulk Power Systems Automation of the Smart Grid at Transmission Level, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid, Applications for Adaptive Control and Optimization.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Penetration and Variability Issues Associated with Sustainable Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits. **Interoperability, Standards, and Cyber Security:** Introduction, Interoperability, Standards, Smart Grid Cyber Security, Cyber Security and Possible Operation for Improving Methodology for Other Users.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Research, Education, and Training for the Smart Grid: Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development. **Case Studies and Test beds for the Smart Grid:** Introduction, Demonstration Projects, Advanced Metering, Microgrid with Renewable Energy, Power System Unit Commitment (UC) Problem,ADP for Optimal Network Reconfiguration in Distribution Automation, Case Study of RER Integration,Testbeds and Benchmark Systems, Challenges of Smart Transmission,Benefits of Smart Transmission.■		**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:

- Discuss the progress made by different stakeholders in the design and development of smart grid.
- Explain measurement techniques using Phasor Measurement Units and smart meters
- Discuss tools for the analysis of smart grid and design, operation and performance
- Discuss classical optimization techniques and computational methods for smart grid design, planning and operation.
- Explain predictive grid management and control technology for enhancing the smart grid performance
- Develop cleaner, more environmentally responsible technologies for the electric system.
- Discuss the computational techniques, communication, measurement, and monitoring technology tools essential to the design of the smart grid.
- Explain methods to promote smart grid awareness and making the existing transmission system smarter by investing in new technology.■

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, , Ethics, Individual and Team Work, Communication, Life-long Learning.

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

15EE831 SMART GRID(Professional Elective) (continued)

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 16 marks.
- There will be 2full 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.■

Textbook

1	Smart Grid, Fundamentals of Design and Analysis	James Momoh	Wiley	1st Edition, 2012

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

OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS (Professional Elective)

Subject Code	15EE832	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss basics of solar resource data, its acquisition and usage.
- To discuss PV technology, buying the PV modules and connecting the modules to form arrays.
- To discuss inverters, system components, cabling used to connect the components and mounting methods of the PV system.
- To explain site assessment, design process of the grid connected system and its sizing.
- To explain installation, commissioning, operation and maintenance of PV systems.
- To explain the types of financial incentives available, calculation of payback time. ■

Module-1	**Teaching Hours**
Solar Resource and Radiation: Solar resources, Quantifying solar radiation, The effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays. **PV Industry and Technology:**Semiconductor devices,Mainstream technologies,Monocrystalline silicon,Multicrystalline/polycrystalline silicon,Thin film solar cells,Contacts,Buying solar modules,Standards,Certifications,Warranties,Emerging technologies,Dye-sensitized solar cells,Sliver cells,Heterojunction with intrinsic thin layer (HIT) photovoltaic cells,III-V Semiconductors,Solar concentrators. **PV Cells, Modules and Arrays:**Characteristics of PV cells,Graphic representations of PV cell performance,Connecting PV cells to create a module,Specification sheets,Creating a string of modules,Creating an array,Photovoltaic array performance,Irradiance,Temperature,Shading.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2	
Inverters and Other System Components: Introduction, Inverters,Battery inverters,Grid-interactive inverters,Transformers,Mainstream inverter technologies,String inverters,Multi-string inverter,Central inverter,Modular inverters,Inverter protection systems,Self-protection,Grid protection,Balance of system equipment: System equipment excluding the PV array and inverter,Cabling,PV combiner box,Module junction box,Circuit breakers and fuses,PV main disconnects/isolators,Lightning and surge protection,System monitoring,Metering,Net metering,Gross metering. Mounting Systems:Roof mounting systems,Pitched roof mounts,Pitched roof mounts for tiled roofs,Pitched roof mounts for metal roofs,Rack mounts,Direct mounts,Building-integrated systems,Ground mounting systems,Ground rack mounts,Pole mounts,Sun-tracking systems,Wind loading,Lightning protection.■	**08**
Revised Bloom's Taxonomy Level L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3	
Site Assessment: Location of the PV array,Roof specifications,Is the site shade-free?,Solar Pathfinder,SolmetricSuneye,HORIcatcher,iPhone apps,Software packages,Available area,Portrait installation,Landscape installation,Energy efficiency initiatives,Health, safety and environment (HSE) risks,Local environment,Locating balance of system equipment,Site plan. **Designing Grid-connected PV Systems:**Design brief,Existing system evaluation,Choosing system components,Modules,Mounting structure,Inverters,Cabling,Voltage sizing,Current sizing,Monitoring,System protection,Over-current protection,Fault-current protection,Lightning and surge protection,Grounding/earthing,Mechanical protection,Array protection,Sub-array protection,Extra low voltage (ELV) segmentation. **Sizing a PV System:**Introduction, Matching voltage specifications,Calculating maximum voltage,Calculating minimum voltage,Calculating the minimum number of modules in a string,Calculating the maximum voltage,Calculating the maximum number of modules in a string,Calculating the	**08**

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

15EE832 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:

- Discuss basics of solar resource data, its acquisition and usage.
- Explain PV technology, buying the PV modules and connecting the modules to form arrays.
- 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 2full 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.■

B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII				
15EE832 OPERATION AND MAINTENANCE OF SOLAR ELECTRICSYSTEMS (Professional Elective)(continued)				
Textbook				
1	Grid-connected Solar Electric Systems, The Earthscan Expert Handbook for Planning, Design and Installation	Geoff Stapleton and Susan Neill	Earthscan	1st Edition, 2012

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

INTEGRATION OF DISTRIBUTED GENERATION(Professional Elective)

Subject Code	15EE833	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To explain power generation by alternate energy source like wind power and solar power.
- To explain selection of size of units and location for wind and solar systems.
- Discuss the effects of integration of distributed generation on the performance the system.
- To provide practical and useful information about grid integration of distributed generation.■

Module-1		**Teaching Hours**
Distributed Generation: Introduction,Sources of Energy - Wind Power, Solar Power, Combined Heat-and-Power, Hydropower, Tidal Power, Wave Power, Geothermal Power, Thermal Power Plants.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
Distributed Generation (continued): Interface with the Grid. **Power System Performance**: Impact of Distributed Generation on the Power System, Aims of the Power System, Hosting Capacity Approach, Power Quality, Voltage Quality and Design of Distributed Generation, Hosting Capacity Approach for Events, Increasing the Hosting Capacity. **Overloading and Losses**: Impact of Distributed Generation, Overloading: Radial Distribution Networks, Overloading: Redundancy and Meshed Operation, Losses.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Overloading and Losses(continued): Increasing the Hosting Capacity. **Voltage Magnitude Variations:** Impact of Distributed Generation, Voltage Margin and Hosting Capacity, Design of Distribution Feeders, A Numerical Approach to Voltage Variations, Tap Changers with Line-Drop Compensation, Probabilistic Methods for Design of Distribution Feeders.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
Voltage Magnitude Variations (continued): Statistical Approach to Hosting Capacity, Increasing the Hosting Capacity. **Power Quality Disturbances:** Impact of Distributed Generation, Fast Voltage Fluctuations, Voltage Unbalance.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Power Quality Disturbances (continued): Low-Frequency Harmonics, High-Frequency Distortion, Voltage Dips, Increasing the Hosting Capacity.■		**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:

- Explain energy generation by wind power and solar power.
- Discuss the variation in production capacity at different timescales, the size of individual units, and the flexibility in choosing locations with respect to of wind and solar systems.

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

15EE833 INTEGRATION OF DISTRIBUTED GENERATION(Professional Elective)(continued)

Course outcomes (continued):

- Explain the performance of the system when distributed generation is integrated to the system.
- Discuss effects of the integration of DG: the increased risk of overload and increased losses.
- Discuss effects of the integration of DG: increased risk of overvoltages, increased levels of power quality disturbances.
- Discuss effects of the integration of DG: incorrect operation of the protection
- Discuss the impact the integration of DG on power system stability and operation. ■

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, 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 2full 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.■

Textbook

1	Integration ofDistributedGeneration in thePower System	Math Bollen	Wiley	2011

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

POWER SYSTEM IN EMERGENCIES(Professional Elective)

Subject Code	15EE834	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

Credits - 03

Course objectives:

- To discuss the disturbances that may occur in a power system and the impact of them on its viable operation.
- To give the definitions, concepts and standard terminology used in the literature on emergency control and to discuss the effect of system structure on the form of emergency control.
- To discuss the structure, function and alternatives for main transmission.
- To discuss standards of security and quality of supply in planning and operation,timescales and tasks in system operation and control.
- To discuss SCADA facilities - functions, structure, performance criteria, data and human - computer interface.
- To discuss energy management systems, communications, telemetry, telecommand and distributed generation.
- To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk.
- To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration.
- To discuss different simulators that can be used in training.
- To discuss facilities and characteristics for emergency control, qualitative and quantitative benefits of emergency control and emergency control in the future. ■

Module-1		**Teaching Hours**
Disturbances in Power Systems and their Effects: Sudden Disturbance, Predictable Disturbances, Forms of System Failure, Analysis Techniques, Trends in the Development of Analytical Techniques. **Some General Aspects of Emergency Control:** Definitions and Concepts used in Emergency Control, Some Standard Terminology, The Effects of Various Types of Fault or Disturbance on System Performance, Typical Pattern of the Development of a Sudden Disturbance, Conceptual Forms of Emergency Control, Effect of System Structure on the Need for and Implementation of Emergency Control, Design Criteria for Emergency Control Facilities.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying.	
Module-2		
The Power System and its Operational and Control Infrastructure: Structure, The Functions of Interconnection, The Alternatives for Main Transmission, Security and Quality of Supply in Planning and Operation, Timescales in System Operation and Control, SCADA, Energy Management Systems, Communications and Telemetry,Telecommand, Distributed Generation, Flexible AC Transmission Systems (FACTS).■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-3		
Measures to Minimize the Impact of Disturbances: Factors in Onset, Severity and Propagation of a Disturbance, Measures in the Planning Timescale to Minimize the Risk of a Disturbance, Measures in the Operational Timescale to Minimize the Risk and Impact of a Disturbance, Special Protection Schemes, Reduction in the Spread of Disturbances, Measures to Minimize the Impact of Predictable Disturbances, An Approach to Managing Resources, The Control Centre.■		**08**
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding, L_3 – Applying, L_4 – Analysing.	
Module-4		
The Natural Environment - Some Disturbances Reviewed: Introduction, Useful Sources of Information, Extreme Environmental Conditions, Noteworthy Disturbances,Incidents.		**08**

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

15EE834 POWER SYSTEM IN EMERGENCIES(Professional Elective) (continued)

Module-4 (continued)		**Teaching Hours**
Restoration: Introduction, The Range of Disturbed System Conditions, Some General Issues in Restoration, Recovery from an Abnormal Operating Situation, Local Islanding or Localized Loss of Demand, The 'Black Start' Situation,Strategies for Restoration of the Whole System, Aides in Restoration Process, Problems Found in Restoration, Analysis, Simulation and Modelling in Blackstart, Restoration from a Foreseen Disturbance. **Training and Simulators for Emergency Control:** Introduction, Training in General, The Need for Operator Training, The Content of Training, Forms of Training, Training Simulators, The Use of Dispatch Training Simulators in Practice.■		
Revised Bloom's Taxonomy Level	L_1 – Remembering, L_2 – Understanding.	
Module-5		
Plant Characteristics and Control Facilities for Emergency Control and Benefits to be Obtained: Introduction, The Characteristics and Facilities Required for Emergency Control, The System and Demand, System Control Costs for Emergencies, Indirect Costs, The Benefits of Emergency Control, Quantitative Aspects,Is Emergency Control Worthwhile? **Systems and Emergency Control in the Future:** Introduction, Changes in Organization, Restructuring, Unbundling and Emergency Control, Facilities for Emergency Control in the Future, Superconductivity, Contingency Planning and Crisis.■		**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:

- Explain disturbances that may occur in a power system and the impact of them on its operation.
- Give the definitions, concepts and standard terminology used in the literature on emergency control and discuss the effect of system structure on the form of emergency control
- Discuss the structure, function and alternatives for main transmission
- To discuss standards of security and quality of supply in planning and operation,timescales, tasks in system operation and control, SCADA facilities - functions, structure, performance criteria, data and human - computer interface
- To discuss energy management systems, communications, telemetry, telecommand and distributed generation.
- To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk
- To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration
- To discuss different simulators used in training, facilities and characteristics for emergency control, and benefits of emergency control and emergency control in the future. ■

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, 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 2full 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.■

Textbook

1	Power Systems in Emergencies: From Contingency Planning to Crisis Management	U. G. Knight	Wiley	1st Edition, 2001

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

INTERNSHIP / PROFESSIONAL PRACTICE

Subject Code	15EE84	IA 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 speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently. ■

Internship/Professional practice: Students under the guidance ofinternal 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

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 classroom work.
- 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.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

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

15EE84INTERNSHIP / PROFESSIONAL PRACTICE(continued)

Continuous Internal Evaluation

CIE marks for the Internship/Professional practicereport (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.■

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

PROJECT WORK PHASE -II

Subject Code	15EEP85	IA Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	100

Credits - 06

Course objectives:

- 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:

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

- 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 skills
- Communicate 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):
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 Internal marks evaluation shall be based on project report and presentation of the same in a seminar.
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.
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.
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.
The student shall be evaluated based on:
Presentation skill for 30 marks and ability in the Question and Answer session for 20 marks.■

Semester End Examination
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.■

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

SEMINAR

Subject Code	15EES86	IA 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.

- 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:

- 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.
- Apply principles of ethics and respect in interaction with others.■

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.■