VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examination and Syllabus
B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
VII SEMESER

(Effective from Academic year 2015-16)

BOARD OF STUDIES IN ELECTRICAL AND ELECTRONICS ENGINEERING

October 2017

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	Relay 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

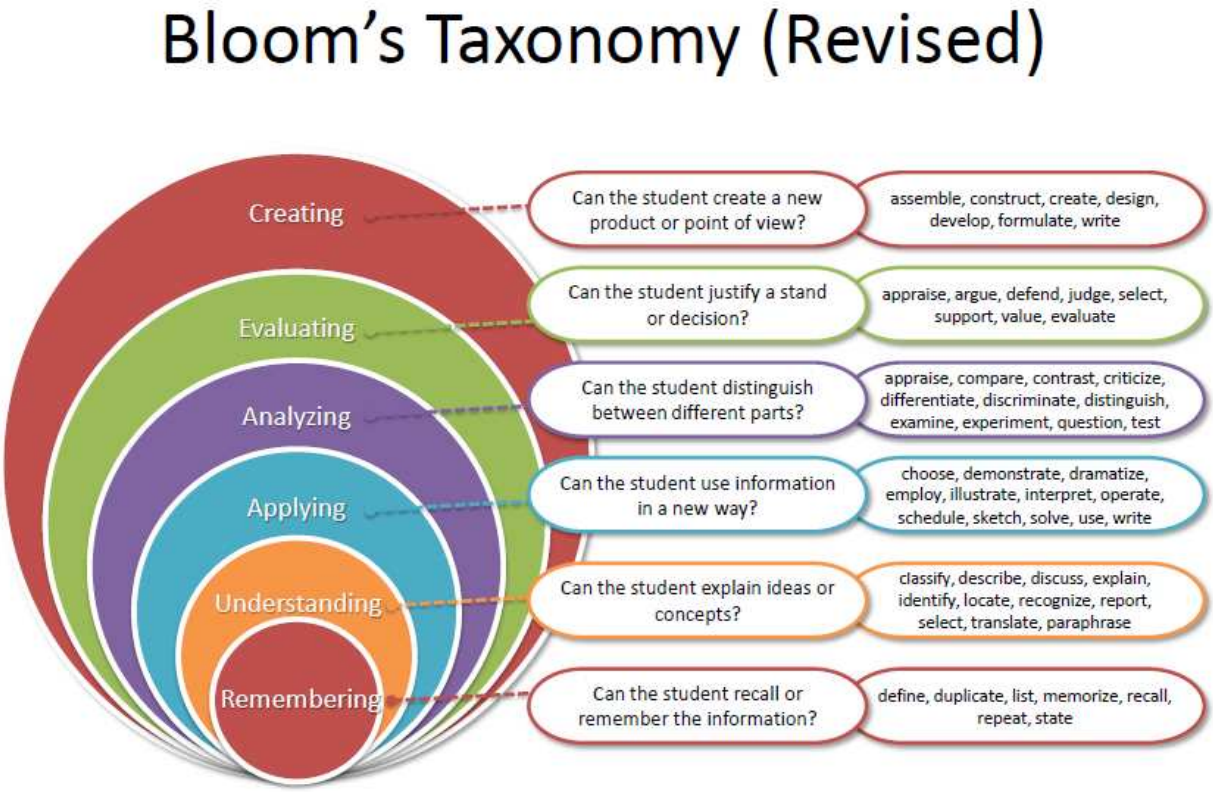
1. Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

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.

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) $L_1 - Rembr$	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) $L_2 - Undrst$	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) $L_3 - Apply$	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) $L_4 - Anlyse$	Students are able to examine and break information into componentparts 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) $L_5 - Evlute$	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) $L_6 - Create$	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)

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-RaphsonMethod, 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, reliability considerations and optimum generation scheduling.

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 SecondaryProcesses, 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 CoronaDischarges. **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)
15EE741ADVANCED CONTROL SYSTEMS(Professional Elective) (continued)
CHOICE BASED CREDIT SYSTEM (CBCS)

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.
- Students will have to answer 5 full questions, selecting one full question from each 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		**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 Considerationsof a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Brief Description and Definitionsof FACTS Controllers, Checklist of Possible Benefits from FACTSTechnology, 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 VoltageInstability, 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**
ElectricalTools, 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 Windingsand General Inspection.Commissioning TestsAs Per National and International Standards - Volts Ratio Earth Resistance, Oil Strength, Insulation Tests, Impulse Tests Polarizing Index, Load Temperature Rise Tests.Specific Tests forDetermination 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 andits 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 thermophotovoltaic 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 Thermophotovoltaic 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 thermophotovoltaic 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

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

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)
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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. ■

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