

# 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
<b>TOTAL</b>					<b>Theory:24 hours Practical: 06 hours</b>		<b>21</b>	<b>240</b>	<b>560</b>	<b>800</b>	<b>24</b>

### 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 VII semester 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
<b>TOTAL</b>					<b>Theory:11 hours Practical: 10 hours</b>		<b>15</b>	<b>310</b>	<b>390</b>	<b>700</b>	<b>20</b>

### 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 VII semester vacation or VII and VIII semester vacation period.

## VII SEMESTER DETAILED SYLLABUS

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VII</b>			
<b>POWER SYSTEM ANALYSIS – 2(Core Course)</b>			
Subject Code	15EE71	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
<b>Credits - 04</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To explain formulation of network models and bus admittance matrix for solving load flow problems.</li> <li>• To discuss solution of nonlinear static load flow equations by different numerical techniques and methods to control voltage profile.</li> <li>• To discuss optimal operation of generators on a bus bar, optimal unit commitment, reliability considerations and optimum generation scheduling.</li> <li>• To discuss optimal power flow solution, scheduling of hydro-thermal system, power system security and reliability.</li> <li>• To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.</li> <li>• To explain numerical solution of swing equation for multi-machine stability. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Load Flow Studies:</b> Introduction, Network Model Formulation, Formation of $Y_{bus}$ by Singular Transformation, Load Flow Problem, Gauss-Seidel Method. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying L <sub>4</sub> – Analysing.		
<b>Module-2</b>			
<b>Load Flow Studies (continued):</b> Newton-Raphson Method, Decoupled Load Flow Methods, Comparison of Load Flow Methods, Control of Voltage Profile. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Optimal System Operation:</b> Introduction, Optimal Operation of Generators on a Bus Bar, Optimal Unit Commitment, Reliability Considerations, Optimum Generation Scheduling. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Optimal System Operation (continued):</b> Optimal Load Flow Solution, Optimal Scheduling of Hydrothermal System, Power System Security, Maintenance Scheduling, Power System Reliability. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying L <sub>4</sub> – Analysing.		
<b>Module-5</b>			
<b>Symmetrical Fault Analysis:</b> Algorithm for Short Circuit Studies, $Z_{bus}$ Formulation. <b>Power System Stability:</b> Numerical Solution of Swing Equation, Multimachine Stability. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying L <sub>4</sub> – Analysing.		
<b>Course outcomes:</b>			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> <li>• Formulate network matrices and models for solving load flow problems.</li> <li>• Perform steady state power flow analysis of power systems using numerical iterative techniques.</li> <li>• Suggest a method to control voltage profile.</li> <li>• Show knowledge of optimal operation of generators on a bus bar, optimal unit commitment,</li> </ul>			

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b> <b>15EE71POWER SYSTEM ANALYSIS – 2(Core Subject) (continued)</b> <b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>				
<b>Course outcomes(continued):</b> <ul style="list-style-type: none"> <li>• Discuss optimal scheduling for hydro-thermal system, power system security and reliability.</li> <li>• Analyze short circuit faults in power system networks using bus impedance matrix.</li> <li>• Perform numerical solution of swing equation for multi-machine stability■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> 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.				
<b>Question paper pattern:</b> <ul style="list-style-type: none"> <li>• The question paper will have ten full questions carrying equal marks.Each full question consisting of 16 marks.</li> <li>• There will be two full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub question covering all the topics under a module.</li> <li>• The students will have to answer five full questions, selecting one full question from each module.</li> </ul>				
<b>Textbook</b>				
1	Modern Power System Analysis	D. P. Kothari	McGraw Hill	4 <sup>th</sup> Edition, 2011
<b>Reference Books</b>				
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>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VII</b>			
<b>POWER SYSTEM PROTECTION(Core Subject)</b>			
Subject Code	15EE72	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
<b>Credits - 04</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss performance of protective relays, components of protection scheme and relay terminology.</li> <li>• To explain relay construction and operating principles.</li> <li>• To explain Overcurrent protection using electromagnetic and static relays and Overcurrent protective schemes.</li> <li>• 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.</li> <li>• To discuss pilot protection; wire pilot relaying and carrier pilot relaying.</li> <li>• To discuss construction, operating principles and performance of various differential relays for differential protection.</li> <li>• To discuss protection of generators, motors, Transformer and Bus Zone Protection.</li> <li>• To explain the principle of circuit interruption and different types of circuit breakers.</li> <li>• To describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.</li> <li>• To discuss protection Against Overvoltages and Gas Insulated Substation (GIS). ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<p><b>Introduction to Power System Protection:</b> 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.</p> <p><b>Relay Construction and Operating Principles:</b> Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.</p> <p><b>Overcurrent Protection:</b> Introduction, Time – current Characteristics, Current Setting, Time Setting. ■</p>			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-2</b>			
<p><b>Overcurrent Protection (continued):</b> 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.</p> <p><b>Distance Protection:</b> 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. ■</p>			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<p><b>Pilot Relaying Schemes:</b> Introduction, Wire Pilot Protection, Carrier Current Protection <b>Differential Protection:</b> Introduction, Differential Relays, Simple Differential Protection, Percentage or Biased Differential Relay, Differential Protection of 3 Phase Circuits, Balanced (Opposed) Voltage Differential Protection.</p> <p><b>Rotating Machines Protection:</b> Introduction, Protection of Generators.</p> <p><b>Transformer and Buszone Protection:</b> Introduction, Transformer Protection, Buszone Protection, Frame Leakage Protection. ■</p>			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE72 POWER SYSTEM PROTECTION (Core Course) (continued)</b>				
<b>Module-4</b>				<b>Teaching Hours</b>
<b>Circuit Breakers:</b> 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 <sub>6</sub> Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers. ■				<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.			
<b>Module-5</b>				
<b>Fuses:</b> Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination. <b>Protection against Overvoltages:</b> 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). <b>Modern Trends in Power System Protection:</b> Introduction, gas insulated substation/switchgear (GIS). ■				<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.			
<b>Course outcomes:</b> At the end of the course the student will be able to:				
<ul style="list-style-type: none"> <li>• Discuss performance of protective relays, components of protection scheme and relay terminology overcurrent protection.</li> <li>• Explain the working of distance relays and the effects of arc resistance, power swings, line length and source impedance on performance of distance relays.</li> <li>• Discuss pilot protection; wire pilot relaying and carrier pilot relaying.</li> <li>• Discuss construction, operating principles and performance of differential relays for differential protection.</li> <li>• Discuss protection of generators, motors, Transformer and Bus Zone Protection.</li> <li>• Explain the principle of circuit interruption in different types of circuit breakers.</li> <li>• Describe the construction and operating principle of different types of fuses and to give the definitions of different terminologies related to a fuse.</li> <li>• Discuss protection against Overvoltages and Gas Insulated Substation (GIS). ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Ethics, Communication, Life-long Learning.				
<b>Question paper pattern:</b>				
<ul style="list-style-type: none"> <li>• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.</li> <li>• There will be two full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub question covering all the topics under a module.</li> <li>• The students will have to answer five full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	Power System Protection and Switchgear	Badri Ram, D.N. Vishwakarma	McGraw Hill	2 <sup>nd</sup> Edition
2	Power System Protection and Switchgear(For additional study on gapless arrester, Refer to pages 458 to 461)	BhuvaneshOza et al	McGraw Hill	1 <sup>st</sup> Edition, 2010

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

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VII</b>			
<b>HIGH VOLTAGE ENGINEERING (Core Course)</b>			
Subject Code	15EE73	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
<b>Credits - 04</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss conduction and breakdown in gases, liquid dielectrics.</li> <li>• To discuss breakdown in solid dielectrics.</li> <li>• To discuss generation of high voltages and currents and their measurement.</li> <li>• To discuss overvoltage phenomenon and insulation coordination in electric power systems.</li> <li>• To discuss non-destructive testing of materials and electric apparatus.</li> <li>• To discuss high-voltage testing of electric apparatus ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Conduction and Breakdown in Gases:</b> 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 $\alpha$ and $\gamma$ , 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. <b>Conduction and Breakdown in Liquid Dielectrics:</b> Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids. <b>Breakdown in Solid Dielectrics:</b> Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-2</b>			
<b>Generation of High Voltages and Currents:</b> 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. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering , L <sub>2</sub> – Understanding L <sub>3</sub> – Applying.		
<b>Module-3</b>			
<b>Measurement of High Voltages and Currents:</b> 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. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering , L <sub>2</sub> – Understanding L <sub>3</sub> – Applying.		
<b>Module-4</b>			
<b>Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems:</b> 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. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-5</b>			
<b>Non-Destructive Testing of Materials and Electrical Apparatus:</b> Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements.			<b>10</b>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE73 HIGH VOLTAGE ENGINEERING (Core Course) (continued)</b>				
<b>Module-5 (continued)</b>				<b>Teaching Hours</b>
<b>High Voltage Testing of Electrical Apparatus:</b> 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. ■				
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.			
<b>Course outcomes:</b> At the end of the course the student will be able to: <ul style="list-style-type: none"> <li>• Explain conduction and breakdown phenomenon in gases, liquid dielectrics.</li> <li>• Explain breakdown phenomenon in solid dielectrics.</li> <li>• Explain generation of high voltages and currents</li> <li>• Discuss measurement techniques for high voltages and currents.</li> <li>• Discuss overvoltage phenomenon and insulation coordination in electric power systems.</li> <li>• Discuss non-destructive testing of materials and electric apparatus and high-voltage testing of electric apparatus ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.				
<b>Question paper pattern:</b> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	High Voltage Engineering	M.S. Naidu, V.Kamaraju	McGraw Hill	5 <sup>th</sup> Edition, 2013.
<b>Reference Books</b>				
1	High Voltage Engineering Fundamentals	E. Kuffel, W.S. Zaengl, J. Kuffel	Newnes	2 <sup>nd</sup> Edition, 2000
2	High Voltage Engineering	Wadhwa C.L.	New Age International	3 <sup>rd</sup> Edition, 2012
3	High-Voltage Test and Measuring Techniques	Wolfgang Hauschild • Eberhard Lemke	Springer	1 <sup>st</sup> Edition 2014
4	High Voltage Engineering	Farouk A.M. Rizk	CRC Press	1 <sup>st</sup> Edition 2014

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>			
<b>ADVANCED CONTROL SYSTEMS( Professional Elective )</b>			
Subject Code	15EE741	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To introduce state variable approach for linear time invariant systems in both the continuous and discrete time systems</li> <li>• To explain development of state models for linear continuous – time and discrete – time systems</li> <li>• To explain application of vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems</li> <li>• To define controllability and observability of a system and testing techniques for controllability and observability of a given system</li> <li>• To explain design techniques of pole assignment and state observer using state feedback.</li> <li>• To explain about inherent and intentional nonlinearities that can occur in control system and developing the describing function for the nonlinearities.</li> <li>• To explain stability analysis of nonlinear systems using describing function analysis.</li> <li>• To explain the analysis of nonlinear systems using Lyapunov function and design of Lyapunov function for stable systems. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>State Variable Analysis and Design:</b> Introduction, Concept of State, State Variables and State Model, State Models for Linear Continuous – Time Systems, State Variables and Linear Discrete – Time Systems. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		
<b>Module-2</b>			
<b>State Variable Analysis and Design (continued):</b> Diagonalization, Solution of State Equations, Concepts of Controllability and Observability. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		
<b>Module-3</b>			
<b>Pole Placement Design and State Observers:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		
<b>Module-4</b>			
<b>Non-linear systems Analysis:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		
<b>Module-5</b>			
<b>Non-linear systems Analysis (continued):</b> Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE741 ADVANCED CONTROL SYSTEMS(Professional Elective) (continued)</b>				
<b>Course outcomes:</b> At the end of the course the student will be able to:				
<ul style="list-style-type: none"> <li>• Discuss state variable approach for linear time invariant systems in both the continuous and discrete time systems.</li> <li>• Develop of state models for linear continuous – time and discrete – time systems.</li> <li>• Apply vector and matrix algebra to find the solution of state equations for linear continuous – time and discrete – time systems.</li> <li>• Define controllability and observability of a system and test for controllability and observability of a given system.</li> <li>• Design pole assignment and state observer using state feedback.</li> <li>• Develop the describing function for the nonlinearity present to assess the stability of the system.</li> <li>• Develop Lyapunov function for the stability analysis of nonlinear systems. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Life-long Learning.				
<b>Question paper pattern:</b>				
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> </ul>				
<b>Textbook</b>				
1	Control Systems Engineering (For the Modules 1 and 2)	I.J. Nagarath and M.Gopal	New Age	5 <sup>th</sup> 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	3 <sup>rd</sup> Edition, 2008

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VII</b>			
<b>UTILIZATION OF ELECTRICAL POWER(Professional Elective)</b>			
Subject Code	15EE742	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss electric heating, air-conditioning and electric welding.</li> <li>• To explain laws of electrolysis, extraction and refining of metals and electro deposition.</li> <li>• To explain the terminology of illumination, laws of illumination, construction and working of electric lamps.</li> <li>• To explain design of interior and exterior lighting systems- illumination levels for various purposes light fittings- factory lighting- flood lighting-street lighting</li> <li>• To discuss systems of electric traction, speed time curves and mechanics of train movement.</li> <li>• To discuss motors used for electric traction and their control.</li> <li>• To discuss braking of electric motors, traction systems and power supply and other traction systems.</li> <li>• Give awareness of technology of electric and hybrid electric vehicles. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Heating and welding:</b> 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.			<b>08</b>
<b>Electrolytic Electro – Metallurgical Process:</b> Ionization, Faraday’s Laws of Electrolysis, Definitions, Extraction of Metals, Refining of Metals, Electro Deposition. ■			
<b>Revised Bloom’s Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<b>Illumination:</b> 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. ■			<b>08</b>
<b>Revised Bloom’s Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Electric Traction Speed - Time Curves and Mechanics of Train Movement:</b> 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.			<b>08</b>
<b>Motors for Electric traction:</b> 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.			
<b>Control of motors:</b> 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. ■			
<b>Revised Bloom’s Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Braking:</b> Introduction, Regenerative Braking with Three Phase Induction Motors, Braking with Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro – Mechanical Drum Brakes.			<b>08</b>
<b>Electric Traction Systems and Power Supply:</b> System of Electric Traction, AC Electrification, Transmission Lines to Sub - Stations, Sub – Stations, Feeding and Distribution System of AC			

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE742 UTILIZATION OF ELECTRICAL POWER(Professional Elective) (continued)</b>				
<b>Module-4 (continued)</b>				<b>Teaching Hours</b>
Traction, Feeding and Distribution System for Dc Tramways, Electrolysis by Currents through Earth, Negative Booster, System of Current Collection, Trolley Wires. <b>Trams, Trolley Buses and Diesel – Electric Traction:</b> Tramways, The Trolley – Bus, Diesel Electric Traction. ■				
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.			
<b>Module-5</b>				
<b>Electric Vehicles:</b> Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving, Energy Consumption. <b>Hybrid Electric Vehicles:</b> Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains. ■				<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.			
<b>Course outcomes:</b>				
At the end of the course the student will be able to:				
<ul style="list-style-type: none"> <li>• Discuss electric heating, air-conditioning and electric welding.</li> <li>• Explain laws of electrolysis, extraction and refining of metals and electro deposition.</li> <li>• Explain the terminology of illumination, laws of illumination, construction and working of electric lamps.</li> <li>• Design interior and exterior lighting systems- illumination levels for factory lighting- flood lighting- street lighting.</li> <li>• Discuss systems of electric traction, speed time curves and mechanics of train movement.</li> <li>• Explain the motors used for electric traction and their control.</li> <li>• Discuss braking of electric motors, traction systems and power supply and other traction systems.</li> <li>• Explain the working of electric and hybrid electric vehicles. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b>				
Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems, The Engineer and Society, Ethics, Individual and Team Work.				
<b>Question paper pattern:</b>				
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	A Textbook on Power System Engineering	A. Chakrabarti et al	Dhanpat Rai and Co	2 <sup>nd</sup> Edition, 2010
2	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design (Chapters 04 and 05 for module 5)	Mehrddad Ehsani et al	CRC Press	1 <sup>st</sup> Edition, 2005
<b>Reference Books</b>				
1	Utilization, Generation and Conservation of Electrical Energy	Sunil S Rao	Khanna Publishers	1 <sup>st</sup> Edition, 2011
2	Utilization of Electric Power and Electric Traction	G.C. Garg	Khanna Publishers	9 <sup>th</sup> Edition, 2014

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VII</b>			
<b>CARBON CAPTURE AND STORAGE(Professional Elective)</b>			
Subject Code	15EE743	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To provide an overview of carbon capture and carbon storage and explain the fundamentals of power generation.</li> <li>• 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.</li> <li>• To explain different geological storage methods including storage in coal seams, depleted gas reservoirs and saline formations.</li> <li>• To explain Carbon dioxide compression and pipeline transport. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Introduction:</b> The Carbon Cycle, Mitigating Growth of The Atmospheric Carbon Inventory, The Process of Technology Innovation. <b>Overview of carbon capture and storage:</b> Carbon Capture, Carbon Storage. <b>Power generation fundamentals:</b> Physical and Chemical Fundamentals, Fossil-Fueled Power Plant, Combined Cycle Power Generation, Future Developments in Power-Generation Technology. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<b>Carbon capture from power generation:</b> 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. <b>Carbon capture from industrial processes:</b> Cement Production, Steel Production, Oil Refining, Natural Gas Processing. <b>Absorption capture systems:</b> Chemical and Physical Fundamentals, Absorption Applications in Post Combustion Capture, Absorption Technology RD&D Status. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Adsorption capture systems:</b> Physical and Chemical Fundamentals, Adsorption Process Applications, Adsorption Technology RD&D Status. References and Resources. <b>Membrane separation systems:</b> 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 <sub>2</sub> Separation, Membrane Applications in Natural Gas Processing. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Cryogenic and distillation systems:</b> Physical Fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan–Holmes process for CO <sub>2</sub> – CH <sub>4</sub> separation, RD&D in cryogenic and distillation technologies. <b>Mineral carbonation:</b> Physical and chemical fundamentals, Current state of technology development, Demonstration and deployment outlook. <b>Geological storage:</b> Introduction, Geological and engineering fundamentals, Enhanced oil recovery, Saline aquifer storage, Other geological storage options. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE743 CARBON CAPTURE AND STORAGE(Professional Elective) (continued)</b>				
<b>Module-5</b>				<b>Teaching Hours</b>
<b>Ocean storage:</b> Introduction, Physical, chemical, and biological fundamentals, Direct CO <sub>2</sub> injection, Chemical sequestration, Biological sequestration, <b>Storage in terrestrial ecosystems:</b> Introduction, Biological and chemical fundamentals, Terrestrial carbon storage options, Full GHG accounting for terrestrial storage, Current R&D focus in terrestrial storage. <b>Other sequestration and use options:</b> Enhanced industrial usage, Algal biofuel production. ■				<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.			
<b>Course outcomes:</b> At the end of the course the student will be able to: <ul style="list-style-type: none"> <li>• Discuss the impacts of climate change and the measures that can be taken to reduce emissions.</li> <li>• Discuss carbon capture and carbon storage.</li> <li>• Explain the fundamentals of power generation.</li> <li>• Explain methods of carbon capture from power generation and industrial processes.</li> <li>• Explain different carbon storage methods: storage in coal seams, depleted gas reservoirs and saline formations.</li> <li>• Explain Carbon dioxide compression and pipeline transport. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> Engineering Knowledge				
<b>Question paper pattern:</b> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	Carbon Capture and Storage	Stephen A. Rackley	Elsevier	2010

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VII</b>			
<b>POWER SYSTEM PLANNING (Professional Elective)</b>			
Subject Code	15EE744	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss primary components of power system planning namely load forecasting, evaluation of energy resources, provisions of electricity Act and Energy Conservation Act.</li> <li>• To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution</li> <li>• To explain forecasting of anticipated future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.</li> <li>• To discuss methods to mobilize resources to meet the investment requirement for the power sector</li> <li>• To perform economic appraisal to allocate the resources efficiently and take proper investment decisions</li> <li>• To discuss expansion of power generation and planning for system energy in the country</li> <li>• To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions</li> <li>• To discuss principles of distribution planning, supply rules, network development and the system studies</li> <li>• To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.</li> <li>• To discuss grid reliability, voltage disturbances and their remedies.</li> <li>• To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity.</li> <li>• To discuss market principles and the norms framed by CERC for online trading and exchange in the interstate power market. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Power System:</b> 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. <b>Electricity Forecasting:</b> Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load - Forecast, Reactive – Load Forecast, Unloading of a System. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-2</b>			
<b>Power-System Economics:</b> 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. <b>Generation Expansion:</b> Generation Capacity and Energy, Generation Mix, Conventional Generation Resources, Nuclear Energy, Clean Coal Technologies. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Generation Expansion (continued):</b> Distributed Power Generation, Renovation and Modernisation of Power Plants. <b>Transmission Planning:</b> Transmission Planning Criteria, Right – of – Way, Network Studies, High – Voltage Transmission, Conductors, Sub – Stations, Power Grid, Reactive Power Planning, Energy Storage. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-4</b>			
<b>Distribution:</b> Distribution Deregulation, Planning Principles, Electricity – Supply Rules, Criteria and Standards, Sub – Transmission, Basic Network, Low Voltage Direct Current Electricity,			<b>08</b>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>			
<b>15EE744 POWER SYSTEM PLANNING (Professional Elective) (continued)</b>			
<b>Module-4(continued)</b>			<b>Teaching Hours</b>
<p><b>Distribution(continued):</b> Upgradation of Existing Lines and Sub – Stations, Network Development, System Studies, Urban Distribution, Rural Electrification, Villages Self – Sufficiency in Energy, Community Power, Self – Generation.</p> <p><b>Reliability and Quality:</b> 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. ■</p>			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-5</b>			
<p><b>Demand-Side Planning:</b> Demand Response, Demand – Response Programmes, Demand– Response Technologies, Energy Efficiency, Energy - Economical Products, Efficient – Energy Users, Supply – Side Efficiency, Energy Audit.</p> <p><b>Electricity Market:</b> 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. ■</p>			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<p><b>Course outcomes:</b> At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Discuss primary components of power system planning, planning methodology for optimum power system expansion, various types of generation, transmission and distribution.</li> <li>• Show knowledge of forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools.</li> <li>• Discuss methods to mobilize resources to meet the investment requirement for the power sector</li> <li>• Understand economic appraisal to allocate the resources efficiently and appreciate the investment decisions</li> <li>• 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.</li> <li>• Discuss principles of distribution planning, supply rules, network development and the system studies</li> <li>• Discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis, grid reliability, voltage disturbances and their remedies</li> <li>• 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. ■</li> </ul>			
<p><b>Graduate Attributes (As per NBA)</b> 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.</p>			
<p><b>Question paper pattern:</b></p> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>			
<b>Textbook</b>			
1	Electric Power Planning	A. S. Pabla	McGraw Hill, 2 <sup>nd</sup> Edition, 2016

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VII</b>			
<b>FACTS AND HVDC TRANSMISSION ( Professional Elective )</b>			
Subject Code	15EE751	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• 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.</li> <li>• To explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.</li> <li>• 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.</li> <li>• To describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.</li> <li>• To explain advantages of HVDC power transmission, overview and organization of HVDC system.</li> <li>• To describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.</li> <li>• Explain converter control for HVDC systems, commutation failure, control functions. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>FACTS Concept and General System Considerations:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-2</b>			
<b>Static Shunt Compensators:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Static Series Compensators:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Development of HVDC Technology:</b> Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. <b>Power Conversion:</b> 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE751 FACTS AND HVDC TRANSMISSION (Professional Elective) (continued)</b>				
<b>Module-5</b>				<b>Teaching Hours</b>
<b>Control of HVDC Converter and System:</b> Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability. ■				<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.			
<b>Course outcomes:</b> At the end of the course the student will be able to:				
<ul style="list-style-type: none"> <li>• 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.</li> <li>• Explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.</li> <li>• 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.</li> <li>• Describe series Controllers Thyristor-Controlled Series Capacitor (TCSC) and the Static Synchronous Series Compensator (SSSC) for control of the transmission line current.</li> <li>• Explain advantages of HVDC power transmission, overview and organization of HVDC system.</li> <li>• Describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.</li> <li>• Explain converter control for HVDC systems, commutation failure, control functions ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> 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.				
<b>Question paper pattern:</b>				
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbooks</b>				
1	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems	Narain G Hingorani, Laszlo Gyugyi	Wiley	1 <sup>st</sup> Edition, 2000
2	HVDC Transmission: Power Conversion Applications in Power Systems	Chan-Ki Kim et al	Wiley	1 <sup>st</sup> Edition, 2009
<b>Reference Books</b>				
1	Thyristor Based FACTS Controllers for Electrical Transmission Systems	R. Mohan Mathur, Rajiv K. Varma	Wiley	1 <sup>st</sup> Edition, 2002

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VII</b>			
<b>TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS(Professional Elective)</b>			
Subject Code	15EE752	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• Describe the process to plan, control and implement commissioning of electrical equipment's.</li> <li>• Differentiate the performance specifications of transformer and induction motor.</li> <li>• Demonstrate the routine tests for synchronous machine, induction motor, transformer &amp; switchgears.</li> <li>• Identification of tools and equipment's used for installation and maintenance of electrical equipment.</li> <li>• Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgears.■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Electrical Tools, accessories:</b> 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. <b>Transformers:</b> 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.■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-2</b>			
<b>Synchronous Machines:</b> 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.■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-3</b>			
<b>Induction Motor:</b> 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 ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> –Analysing, L <sub>5</sub> –Evaluating.		
<b>Module-4</b>			
<b>Laying of Underground Cables:</b> Inspection, Storage, Transportation and Handling of Cables, Cable Handling 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■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> –Analysing, L <sub>5</sub> –Evaluating.		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE752 TESTING AND COMMISSIONING OF POWER SYSTEM APPARATUS (Professional Elective) (continued)</b>				
<b>Module-5</b>				<b>Teaching Hours</b>
<p><b>Switchgear and Protective Devices:</b> Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests.</p> <p><b>Domestic Installation:</b> 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 ■</p>				<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> –Analysing, L <sub>5</sub> –Evaluating.			
<p><b>Course outcomes:</b> At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Describe the process to plan, control and implement commissioning of electrical equipment's.</li> <li>• Differentiate the performance specifications of transformer and induction motor.</li> <li>• Demonstrate the routine tests for synchronous machine, induction motor, transformer &amp; switchgears.</li> <li>• Describe corrective and preventive maintenance of electrical equipment's.</li> <li>• Explain the operation of an electrical equipment's such as isolators, circuit breakers, induction motor and synchronous machines. ■</li> </ul>				
<p><b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Ethics, Individual and Team Work, Communication, Life-long Learning.</p>				
<p><b>Question paper pattern:</b></p> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Text/ Reference Books</b>				
1	Testing, Commissioning, Operation and Maintenance of Electrical Equipment	S. Rao	Khanna Publishers	6 <sup>th</sup> Edition, 19 <sup>th</sup> Reprint, 2015
2	Testing and Commissioning of Electrical Equipment	R.L.Chakrasali	Prism Books Pvt Ltd	1 <sup>st</sup> Edition,2014
3	Preventive Maintenance of Electrical Apparatus	S.K.Sharotri	Katson Publishing House	1 <sup>st</sup> Edition, 1980
4	Handbook of Switchgears	BHEL	McGraw Hill	1 <sup>st</sup> Edition, 2005
5	Transformers	BHEL	McGraw Hill	1 <sup>st</sup> Edition, 2003
6	TheJ&P Transformer Book	Martin J. Heathcote	Newnes	12 <sup>th</sup> Edition, 1998

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VII</b>			
<b>SPACECRAFT POWER TECHNOLOGIES(Professional Elective)</b>			
Subject Code	15EE753	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.</li> <li>• To discuss near – earth environmental factors that will affect the design of space craft power systems.</li> <li>• To describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.</li> <li>• To discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.</li> <li>• To discuss, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.</li> <li>• To describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Spacecraft:</b> Introduction, the Beginnings, the Electrical Power System. <b>Environmental Factors:</b> Introduction, Orbital Considerations, The Near-earth Space Environment. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-2</b>			
<b>Solar Energy Conversion:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Solar Energy Conversion (continued):</b> Space Solar Cell Arrays, Space Thermo photovoltaic Power Systems. <b>Chemical Storage and Generation Systems:</b> Introduction, Inventions, Evolution of Batteries in Space, Fundamentals of Electrochemistry, Cell and Battery Mechanical Design, Performance Metrics. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Chemical Storage and Generation Systems (continued):</b> Electrochemical Cell Types, Fuel Cell Systems. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-5</b>			
<b>Power Management and Distribution (PMAD):</b> Introduction, Functions of PMAD, Components and Packaging, System Examples. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Course outcomes:</b>			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> <li>• Discuss the increasing demand for space craft power systems and to give an overview of electrical power system and its technology.</li> <li>• Discuss near – earth environmental factors that will affect the design of space craft power systems.</li> </ul>			

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>				
<b>15EE753 SPACECRAFT POWER TECHNOLOGIES(Professional Elective)(continued)</b>				
<b>Course outcomes(continued):</b>				
<ul style="list-style-type: none"> <li>• Describe the elements of a space photovoltaic power system, the status of solar cell technologies presently in use.</li> <li>• Discuss advances in both cell and array technology, and solar thermo photovoltaic energy conversion.</li> <li>• Discusses, space-qualified components, the array of chemical storage technologies including both batteries and fuel cells.</li> <li>• Describe components and techniques for achieving the various Power Management and Distribution functions and examples of several PMAD configurations. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b>				
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.				
<b>Question paper pattern:</b>				
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	Spacecraft Power Technologies	A.K. Hyder et al	Imperial College Press	1 <sup>st</sup> Edition, 2000
<b>Reference Books</b>				
1	Spacecraft Power Systems	Mukund R. Patel	CRC Press	1 <sup>st</sup> Edition, 2004

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VII</b>			
<b>INDUSTRIAL HEATING ( Professional Elective )</b>			
Subject Code	15EE754	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To explain construction, classification of industrial furnaces and the methods of heat transfer in them</li> <li>• To discuss heating capacity of batch furnaces</li> <li>• To discuss heating capacity of continuous furnaces</li> <li>• To discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.</li> <li>• To explain operation and control of industrial furnaces. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Industrial Heating Processes:</b> Industrial Process Heating Furnaces, Classifications of Furnaces, Elements of Furnace Construction.			<b>08</b>
<b>Heat Transfer in Industrial Furnaces:</b> 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. ■			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<b>Heating Capacity of Batch Furnaces:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Heating Capacity of Continuous Furnaces:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Saving Energy in Industrial Furnace Systems:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-5</b>			
<b>Operation and Control of Industrial Furnaces:</b> Burner and Flame Types, Location, Flame Fitting, Unwanted NO <sub>x</sub> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b> <b>CHOICE BASED CREDIT SYSTEM (CBCS)</b> <b>SEMESTER - VII</b>				
<b>15EE754 INDUSTRIAL HEATING (Professional Elective) (continued)</b>				
<b>Course outcomes:</b> At the end of the course the student will be able to: <ul style="list-style-type: none"> <li>• Explain construction, classification of industrial furnaces</li> <li>• Discuss the methods of heat transfer in industrial furnaces.</li> <li>• Discuss heating capacity of batch furnaces and continuous furnaces</li> <li>• Discuss methods of saving energy in industrial furnace systems and fuel consumption calculation.</li> <li>• Explain operation and control of industrial furnaces. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Conduct investigations of complex problems.				
<b>Question paper pattern:</b> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	Industrial Furnaces	W. Trinks	Wiley	6 <sup>th</sup> Edition, 2004

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VII</b>			
<b>POWER SYSTEM SIMULATION LABORATORY</b>			
Subject Code	15EEL76	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80
<b>Credits - 02</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To explain the use of MATLAB package to assess the performance of medium and long transmission lines.</li> <li>• To explain the use of MATLAB package to obtain the power angle characteristics of salient and non-salient pole alternator.</li> <li>• To explain the use of MATLAB package to study transient stability of radial power systems under three phase fault conditions.</li> <li>• To explain the use of MATLAB package to develop admittance and impedance matrices of interconnected power systems.</li> <li>• To explain the use of Mi-Power package to solve power flow problem for simple power systems.</li> <li>• To explain the use of Mi-Power package to perform fault studies for simple radial power systems.</li> <li>• To explain the use of Mi-Power package to study optimal generation scheduling problems for thermal power plants. ■</li> </ul>			
<b>Sl. No</b>	<b>Experiments</b>		
1	<b>Use of MATLAB package</b>	Formation for symmetric $\pi$ /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	<b>Use of Mi-Power package</b>	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 PQ and 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.	
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating, L <sub>6</sub> – Creating.		
<b>Course outcomes:</b>			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> <li>• Develop a program in MATLAB to assess the performance of medium and long transmission lines.</li> <li>• Develop a program in MATLAB to obtain the power angle characteristics of salient and non-salient pole alternator.</li> <li>• Develop a program in MATLAB to assess the transient stability under three phase fault at different locations in a of radial power systems.</li> <li>• Develop programs in MATLAB to formulate bus admittance and bus impedance matrices of interconnected power systems.</li> <li>• Use Mi-Power package to solve power flow problem for simple power systems.</li> <li>• Use Mi-Power package to study unsymmetrical faults at different locations in radial power systems</li> <li>• Use of Mi-Power package to study optimal generation scheduling problems for thermal power plants. ■</li> </ul>			

<p style="text-align: center;"><b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)</b> <b>CHOICE BASED CREDIT SYSTEM (CBCS)</b> <b>SEMESTER - VII</b></p>
<p style="text-align: center;"><b>15EEL76POWER SYSTEM SIMULATION LABORATORY (continued)</b></p>
<p><b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.</p>
<p><b>Conduct of Practical Examination:</b></p> <ol style="list-style-type: none"><li>1. All laboratory experiments are to be included for practical examination.</li><li>2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.</li><li>3. Students can pick one experiment from the questions lot prepared by the examiners.</li><li>4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■</li></ol>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VII</b>			
<b>RELY AND HIGH VOLTAGE LABORATORY</b>			
Subject Code	15EEL77	IA Marks	20
Number of Practical Hours/Week	03	Exam Hours	03
Total Number of Practical Hours	42	Exam Marks	80
<b>Credits - 02</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To conduct experiments to verify the characteristics of over current, over voltage, under voltage relays both electromagnetic and static type.</li> <li>• To verify the operation of negative sequence relay.</li> <li>• To conduct experiments to verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.</li> <li>• To conduct experiments on generator, motor and feeder protection.</li> <li>• To conduct experiments to study the sparkover characteristics for both uniform and non-uniform configurations using High AC and DC voltages.</li> <li>• To measure high AC and DC voltages</li> <li>• To experimentally measure the breakdown strength of transformer oil.</li> <li>• 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. ■</li> </ul>			
Sl. NO	<b>Experiments</b>		
<b>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.</b>			
1	<b>Part - A</b>	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	<b>Part - B</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	<b>Part - C</b>	Generation Protection: Merz Price Scheme.	
8		Feeder Protection against Faults.	
9		Motor Protection against Faults.	
10	<b>Part - D</b>	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.	
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating, L <sub>6</sub> – Creating		

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b> <b>CHOICE BASED CREDIT SYSTEM (CBCS)</b> <b>SEMESTER -VII</b>
<b>15EEL77 RELY AND HIGH VOLTAGE LABORATORY (continued)</b>
<p><b>Course outcomes:</b></p> <p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Experimentally verify the characteristics of over current, over voltage, under voltage and negative sequence relays both electromagnetic and static type.</li> <li>• Experimentally verify the characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.</li> <li>• Show knowledge of protecting generator, motor and feeders.</li> <li>• Analyze the spark over characteristics for both uniform and non-uniform configurations using High AC and DC voltages.</li> <li>• Measure high AC and DC voltages and breakdown strength of transformer oil.</li> <li>• <b>Draw electric field and</b> measure the capacitance of different electrode configuration models.</li> <li>• Show knowledge of generating standard lightning impulse voltage to determine efficiency, energy of impulse generator and 50% probability flashover voltage for air insulation. ■</li> </ul>
<p><b>Graduate Attributes (As per NBA)</b></p> <p>Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.</p>
<p><b>Conduct of Practical Examination:</b></p> <ol style="list-style-type: none"> <li>1. All laboratory experiments are to be included for practical examination.</li> <li>2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.</li> <li>3. Students can pick one experiment from the questions lot prepared by the examiners.</li> <li>4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. ■</li> </ol>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VII</b>			
<b>PROJECT PHASE – I AND SEMINAR</b>			
Subject Code	15EEP78	IA Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	--
<b>Credits - 02</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• Support independent learning.</li> <li>• Guide to select and utilize adequate information from varied resources maintaining ethics.</li> <li>• Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.</li> <li>• Develop interactive, communication, organisation, time management, and presentation skills.</li> <li>• Impart flexibility and adaptability.</li> <li>• Inspire independent and team working.</li> <li>• Expand intellectual capacity, credibility, judgement, intuition.</li> <li>• Adhere to punctuality, setting and meeting deadlines.</li> <li>• Instil responsibilities to oneself and others.</li> <li>• 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. ■</li> </ul>			
<p><b>Project Phase-1</b> 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</p> <p><b>Seminar:</b> Each student, under the guidance of a Faculty, is required to</p> <ul style="list-style-type: none"> <li>• Present the seminar on the selected project orally and/or through power point slides.</li> <li>• Answer the queries and involve in debate/discussion.</li> <li>• Submit two copies of the typed report with a list of references.</li> </ul> <p>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. ■</p>			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating, L <sub>6</sub> – Creating.		
<b>Course outcomes:</b>			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> <li>• Demonstrate a sound technical knowledge of their selected project topic.</li> <li>• Undertake problem identification, formulation and solution.</li> <li>• Design engineering solutions to complex problems utilising a systems approach.</li> <li>• Communicate with engineers and the community at large in written and oral forms.</li> <li>• Demonstrate the knowledge, skills and attitudes of a professional engineer. ■</li> </ul>			
<b>Graduate Attributes (As per NBA)</b>			
Engineering Knowledge, Problem Analysis, Individual and Team work, Communication.			
<b>Continuous Internal Evaluation</b>			
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>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VIII</b>			
<b>POWER SYSTEM OPERATION AND CONTROL(Core Course)</b>			
Subject Code	15EE81	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
<b>Credits - 04</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To describe various levels of controls in power systems and the vulnerability of the system.</li> <li>• To explain components, architecture and configuration of SCADA.</li> <li>• To define unit commitment and explain various constraints in unit commitment and the solution methods</li> <li>• To explain issues of hydrothermal scheduling and solutions to hydro thermal problems</li> <li>• To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control</li> <li>• To explain automatic generation control, voltage and reactive power control in an interconnected power system.</li> <li>• To explain reliability and contingency analysis, state estimation and related issues. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Introduction:</b> Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centres. <b>Supervisory Control and Data acquisition (SCADA):</b> 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. <b>Unit Commitment:</b> Introduction, SimpleEnumeration Constraints, Priority List Method, DynamicProgramming Method for Unit Commitment. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>4</sub> – Analysing.		
<b>Module-2</b>			
<b>Hydro-thermal Scheduling:</b> 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. <b>Automatic Generation Control (AGC):</b> Introductions, Basic Generator Control Loops, Commonly used Terms in AGC, Functions of AGC, Speed Governors. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Automatic Generation Control (continued):</b> Mathematical Model of Automatic Load Frequency Control, AGC Controller, Proportional Integral Controller. <b>Automatic Generation Control in interconnected Power system:</b> Introductions, Tie - Line Control with Primary Speed Control, Frequency Bias Tie - Line Control, State-Space Models. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – Applying.		
<b>Module-4</b>			
<b>Automatic Generation Control in interconnected Power system (continued):</b> State-Space Model for Two - Area System, Tie-Line Oscillations, Related Issues in Implementation of AGC. <b>Voltage and Reactive Power Control:</b> 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. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – 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
<b>Power System Reliability and Security:</b> Introduction, Security Levels of System, Reliability Cost, Adequacy Indices, Functions of System Security, Contingency Analysis, Linear Sensitivity Factors, Contingency Selection and Ranking. <b>State estimation of Power Systems:</b> Introduction, Linear Least Square Estimation, DC State Estimator, Other Issues in State Estimation. ■				<b>10</b>
<b>Revised Bloom's Taxonomy Level</b> L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.				
<b>Course outcomes:</b> At the end of the course the student will be able to: <ul style="list-style-type: none"> <li>• Describe various levels of controls in power systems, the vulnerability of the system, components, architecture and configuration of SCADA.</li> <li>• Solve unit commitment problems</li> <li>• Explain issues of hydrothermal scheduling and solutions to hydro thermal problems</li> <li>• Explain basic generator control loops, functions of Automatic generation control, speed governors</li> <li>• Develop and analyze mathematical models of Automatic Load Frequency Control</li> <li>• Explain automatic generation control, voltage and reactive power control in an interconnected power system.</li> <li>• Explain reliability, security, contingency analysis, state estimation and related issues of power systems. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Conduct investigations of complex problems, Modern Tool Usage, Communication, Life-long Learning.				
<b>Question paper pattern:</b> <ul style="list-style-type: none"> <li>• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.</li> <li>• There will be two full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub question covering all the topics under a module.</li> <li>• The students will have to answer five full questions, selecting one full question from each module.</li> </ul>				
<b>Textbook</b>				
1	Power System Operation and Control	K. Uma Rao	Wiley	1 <sup>st</sup> Edition, 2012
<b>Reference Books</b>				
1	Power Generation Operation and Control	Allen J Wood etal	Wiley	2nd Edition, 2003
2	Power System Stability and Control	Kundur	McGraw Hill	8 <sup>th</sup> Reprint, 2009

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER -VIII</b>			
<b>INDUSTRIAL DRIVES AND APPLICATIONS(Core Course)</b>			
Subject Code	15EE82	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
<b>Credits - 04</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To define electric drive, its parts, advantages and explain choice of electric drive.</li> <li>• To explain dynamics and modes of operation of electric drives.</li> <li>• To explain selection of motor power ratings and control of dc motor using rectifiers.</li> <li>• To analyze the performance of induction motor drives under different conditions.</li> <li>• To explain the control of induction motor, synchronous motor and stepper motor drives.</li> <li>• To discuss typical applications electrical drives in the industry. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Electrical Drives:</b> Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives. <b>Dynamics of Electrical Drives:</b> Fundamental Torque Equations, Speed Torque Conventions and Multiquadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization. <b>Control Electrical Drives:</b> Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-2</b>			
<b>Selection of Motor Power Ratings:</b> Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. <b>Direct Current Motor Drives:</b> Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase 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 From Fully Controlled Rectifier, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Induction Motor Drives:</b> Analysis and Performance of Three 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. ■			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating.		
<b>Module-4</b>			
<b>Induction Motor Drives (continued):</b> 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. <b>Synchronous Motor Drives:</b> Operation from fixed frequency supply-starting, synchronous motor			<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – 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
<p><b>Synchronous Motor Drives (continued):</b>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.</p> <p><b>Stepper Motor Drives:</b> Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor.</p> <p><b>Industrial Drives:</b>Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools. ■</p>				<b>10</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.			
<p><b>Course outcomes:</b> At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Explain the advantages and choice of electric drive.</li> <li>• Explain dynamics and different modes of operation of electric drives.</li> <li>• Suggest a motor for a drive and control of dc motor using controlled rectifiers.</li> <li>• Analyze the performance of induction motor drives under different conditions.</li> <li>• Control induction motor, synchronous motor and stepper motor drives.</li> <li>• Suggest a suitable electrical drive for specific application in the industry. ■</li> </ul>				
<p><b>Graduate Attributes (As per NBA)</b> Engineering Knowledge, Problem Analysis, Design/ Development of Solutions, Modern Tool Usage.</p>				
<p><b>Question paper pattern:</b></p> <ul style="list-style-type: none"> <li>• The question paper will have ten full questions carrying equal marks. Each full question consisting of 16 marks.</li> <li>• There will be two full questions (with a maximum of four sub questions) from each module.</li> <li>• Each full question will have sub question covering all the topics under a module.</li> <li>• The students will have to answer five full questions, selecting one full question from each module.</li> </ul>				
<b>Textbook</b>				
1	Fundamentals of Electrical Drives	Gopal K. Dubey	Narosa Publishing House	2 <sup>nd</sup> Edition, 2001
2	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives under module 5.)	VedumSubrahmanyam	McGraw Hill	2 <sup>nd</sup> Edition, 2011
<b>Reference Books</b>				
1	Electric Drives	N.K De,P.K. Sen	PHI Learning	1 <sup>st</sup> Edition, 2009

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER –VIII</b>			
<b>SMART GRID(Professional Elective)</b>			
Subject Code	15EE831	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To define smart grid and discuss the progress made by different stakeholders in the design and development of smart grid.</li> <li>• To explain the measurement techniques using PMUs and smart meters.</li> <li>• To discuss tools for the analysis of smart grid and design, operation and performance.</li> <li>• To discuss incorporating performance tools such as voltage and angle stability and state estimation into smart grid.</li> <li>• To discuss classical optimization techniques and computational methods for smart grid design, planning and operation.</li> <li>• To discuss the development of predictive grid management and control technology for enhancing the smart grid performance.</li> <li>• To discuss development of cleaner, more environmentally responsible technologies for the electric system.</li> <li>• To discuss the fundamental tools and techniques essential to the design of the smart grid.</li> <li>• To describe methods to promote smart grid awareness and enhancement.</li> <li>• To discuss methods to make the existing transmission system smarter by investing in new technology. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<p><b>Smart Grid Architectural Designs:</b> 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.</p> <p><b>Smart Grid Communications and Measurement Technology:</b> Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Microgrid and Smart Grid Comparison.</p> <p><b>Performance Analysis Tools for Smart Grid Design:</b> 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. ■</p>			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<p><b>Stability Analysis Tools for Smart Grid:</b> 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. ■</p>			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<p><b>Computational Tools for Smart Grid Design:</b> Introduction to Computational Tools, Decision Support Tools, Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto</p>			<b>08</b>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER –VIII</b>		
<b>15EE831 SMART GRID(Professional Elective) (continued)</b>		
<b>Module-3 (continued)</b>	<b>Teaching Hours</b>	
Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges. <b>Pathway for Designing Smart Grid:</b> 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. ■		
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.	
<b>Module-4</b>		
<b>Renewable Energy and Storage:</b> 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. <b>Interoperability, Standards, and Cyber Security:</b> Introduction, Interoperability, Standards, Smart Grid Cyber Security, Cyber Security and Possible Operation for Improving Methodology for Other Users. ■		<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.	
<b>Module-5</b>		
<b>Research, Education, and Training for the Smart Grid:</b> Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development. <b>Case Studies and Test beds for the Smart Grid:</b> 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. ■		<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.	
<b>Course outcomes:</b>		
At the end of the course the student will be able to: <ul style="list-style-type: none"> <li>• Discuss the progress made by different stakeholders in the design and development of smart grid.</li> <li>• Explain measurement techniques using Phasor Measurement Units and smart meters</li> <li>• Discuss tools for the analysis of smart grid and design, operation and performance</li> <li>• Discuss classical optimization techniques and computational methods for smart grid design, planning and operation.</li> <li>• Explain predictive grid management and control technology for enhancing the smart grid performance</li> <li>• Develop cleaner, more environmentally responsible technologies for the electric system.</li> <li>• Discuss the computational techniques, communication, measurement, and monitoring technology tools essential to the design of the smart grid.</li> <li>• Explain methods to promote smart grid awareness and making the existing transmission system smarter by investing in new technology. ■</li> </ul>		
<b>Graduate Attributes (As per NBA)</b>		
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>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER –VIII</b>				
<b>15EE831 SMART GRID(Professional Elective) (continued)</b>				
<b>Question paper pattern:</b>				
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module.■</li> </ul>				
<b>Textbook</b>				
1	Smart Grid, Fundamentals of Design and Analysis	James Momoh	Wiley	1 <sup>st</sup> Edition, 2012

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VIII</b>			
<b>OPERATION AND MAINTENANCE OF SOLAR ELECTRIC SYSTEMS (Professional Elective)</b>			
Subject Code	15EE832	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss basics of solar resource data, its acquisition and usage.</li> <li>• To discuss PV technology, buying the PV modules and connecting the modules to form arrays.</li> <li>• To discuss inverters, system components, cabling used to connect the components and mounting methods of the PV system.</li> <li>• To explain site assessment, design process of the grid connected system and its sizing.</li> <li>• To explain installation, commissioning, operation and maintenance of PV systems.</li> <li>• To explain the types of financial incentives available, calculation of payback time. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<p><b>Solar Resource and Radiation:</b>Solar resources, Quantifying solar radiation, The effect of the Earth's atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays.</p> <p><b>PV Industry and Technology:</b>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.</p> <p><b>PV Cells, Modules and Arrays:</b>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.■</p>			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<p><b>Inverters and Other System Components:</b>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.</p> <p>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.■</p>			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<p><b>Site Assessment:</b>Location of the PV array,Roof specifications,Is the site shade-free?,Solar Pathfinder,SolmetricSuneye,HORlcatcher,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.</p> <p><b>Designing Grid-connected PV Systems:</b>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.</p> <p><b>Sizing a PV System:</b>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</p>			<b>08</b>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII</b>		
<b>15EE832 OPERATION AND MAINTENANCE OF SOLAR ELECTRIC SYSTEMS (Professional Elective)(continued)</b>		
<b>Module-3 (continued)</b>	<b>Teaching Hours</b>	
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. ■		
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.	
<b>Module-4</b>		
<b>Installing Grid-connected PV Systems:</b> 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. <b>System Commissioning:</b> Introduction, Final inspection of system installation, Testing, Commissioning, System documentation. <b>System Operation and Maintenance:</b> System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, Other common problems. ■	<b>08</b>	
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.	
<b>Module-5</b>		
<b>Marketing and Economics of Grid-connected PV Systems:</b> 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. <b>Case Studies:</b> Case studies A to G. ■	<b>08</b>	
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.	
<b>Course outcomes:</b> At the end of the course the student will be able to:		
<ul style="list-style-type: none"> <li>• Discuss basics of solar resource data, its acquisition and usage.</li> <li>• Explain PV technology, buying the PV modules and connecting the modules to form arrays.</li> <li>• Explain the use of inverters, other system components, cabling used to connect the components and mounting methods of the PV system.</li> <li>• Assess the site for PV system installation.</li> <li>• Design a grid connected system and compute its size.</li> <li>• Explain installation, commissioning, operation and maintenance of PV systems.</li> <li>• Explain the types of financial incentives available, calculation of payback time ■</li> </ul>		
<b>Graduate Attributes (As per NBA)</b> 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.		
<b>Question paper pattern:</b>		
<ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>		

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

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER -VIII</b>			
<b>INTEGRATION OF DISTRIBUTED GENERATION(Professional Elective)</b>			
Subject Code	15EE833	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To explain power generation by alternate energy source like wind power and solar power.</li> <li>• To explain selection of size of units and location for wind and solar systems.</li> <li>• Discuss the effects of integration of distributed generation on the performance the system.</li> <li>• To provide practical and useful information about grid integration of distributed generation. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Distributed Generation:</b> Introduction,Sources of Energy - Wind Power, Solar Power, Combined Heat-and-Power, Hydropower, Tidal Power, Wave Power, Geothermal Power, Thermal Power Plants. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<b>Distributed Generation (continued):</b> Interface with the Grid. <b>Power System Performance:</b> 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. <b>Overloading and Losses:</b> Impact of Distributed Generation, Overloading: Radial Distribution Networks, Overloading: Redundancy and Meshed Operation, Losses. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Overloading and Losses(continued):</b> Increasing the Hosting Capacity. <b>Voltage Magnitude Variations:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>Voltage Magnitude Variations (continued):</b> Statistical Approach to Hosting Capacity, Increasing the Hosting Capacity. <b>Power Quality Disturbances:</b> Impact of Distributed Generation, Fast Voltage Fluctuations, Voltage Unbalance. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-5</b>			
<b>Power Quality Disturbances (continued):</b> Low-Frequency Harmonics, High-Frequency Distortion, Voltage Dips, Increasing the Hosting Capacity. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Course outcomes:</b>			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> <li>• Explain energy generation by wind power and solar power.</li> <li>• 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.</li> </ul>			

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b> <b>CHOICE BASED CREDIT SYSTEM (CBCS)</b> <b>SEMESTER - VIII</b>				
<b>15EE833 INTEGRATION OF DISTRIBUTED GENERATION(Professional Elective)(continued)</b>				
<b>Course outcomes (continued):</b> <ul style="list-style-type: none"> <li>• Explain the performance of the system when distributed generation is integrated to the system.</li> <li>• Discuss effects of the integration of DG: the increased risk of overload and increased losses.</li> <li>• Discuss effects of the integration of DG: increased risk of overvoltages, increased levels of power quality disturbances.</li> <li>• Discuss effects of the integration of DG: incorrect operation of the protection</li> <li>• Discuss the impact the integration of DG on power system stability and operation. ■</li> </ul>				
<b>Graduate Attributes (As per NBA)</b> 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.				
<b>Question paper pattern:</b> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>				
<b>Textbook</b>				
1	Integration of Distributed Generation in the Power System	Math Bollen	Wiley	2011

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VIII</b>			
<b>POWER SYSTEM IN EMERGENCIES(Professional Elective)</b>			
Subject Code	15EE834	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80
<b>Credits - 03</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To discuss the disturbances that may occur in a power system and the impact of them on its viable operation.</li> <li>• 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.</li> <li>• To discuss the structure, function and alternatives for main transmission.</li> <li>• To discuss standards of security and quality of supply in planning and operation, timescales and tasks in system operation and control.</li> <li>• To discuss SCADA facilities - functions, structure, performance criteria, data and human - computer interface.</li> <li>• To discuss energy management systems, communications, telemetry, telecommand and distributed generation.</li> <li>• To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk.</li> <li>• To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration.</li> <li>• To discuss different simulators that can be used in training.</li> <li>• To discuss facilities and characteristics for emergency control, qualitative and quantitative benefits of emergency control and emergency control in the future. ■</li> </ul>			
<b>Module-1</b>			<b>Teaching Hours</b>
<b>Disturbances in Power Systems and their Effects:</b> Sudden Disturbance, Predictable Disturbances, Forms of System Failure, Analysis Techniques, Trends in the Development of Analytical Techniques. <b>Some General Aspects of Emergency Control:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying.		
<b>Module-2</b>			
<b>The Power System and its Operational and Control Infrastructure:</b> 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). ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-3</b>			
<b>Measures to Minimize the Impact of Disturbances:</b> 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. ■			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding, L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing.		
<b>Module-4</b>			
<b>The Natural Environment - Some Disturbances Reviewed:</b> Introduction, Useful Sources of Information, Extreme Environmental Conditions, Noteworthy Disturbances, Incidents.			<b>08</b>

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING(EEE) CHOICE BASED CREDIT SYSTEM (CBCS) SEMESTER - VIII</b>			
<b>15EE834 POWER SYSTEM IN EMERGENCIES(Professional Elective) (continued)</b>			
<b>Module-4 (continued)</b>			<b>Teaching Hours</b>
<p><b>Restoration:</b> 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.</p> <p><b>Training and Simulators for Emergency Control:</b> 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. ■</p>			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<b>Module-5</b>			
<p><b>Plant Characteristics and Control Facilities for Emergency Control and Benefits to be Obtained:</b> 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?</p> <p><b>Systems and Emergency Control in the Future:</b> Introduction, Changes in Organization, Restructuring, Unbundling and Emergency Control, Facilities for Emergency Control in the Future, Superconductivity, Contingency Planning and Crisis. ■</p>			<b>08</b>
<b>Revised Bloom's Taxonomy Level</b>	L <sub>1</sub> – Remembering, L <sub>2</sub> – Understanding.		
<p><b>Course outcomes:</b> At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Explain disturbances that may occur in a power system and the impact of them on its operation.</li> <li>• 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</li> <li>• Discuss the structure, function and alternatives for main transmission</li> <li>• 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</li> <li>• To discuss energy management systems, communications, telemetry, telecommand and distributed generation.</li> <li>• To discuss factors affecting the onset, severity and propagation of a disturbance, measures to minimize the risk</li> <li>• To discuss weather related disturbances that can occur in the power systems and aids to the restoration process and problems which hinder restoration</li> <li>• To discuss different simulators used in training, facilities and characteristics for emergency control, and benefits of emergency control and emergency control in the future. ■</li> </ul>			
<p><b>Graduate Attributes (As per NBA)</b> 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.</p>			
<p><b>Question paper pattern:</b></p> <ul style="list-style-type: none"> <li>• The question paper will have ten questions.</li> <li>• Each full question is for 16 marks.</li> <li>• There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.</li> <li>• Each full question with sub questions will cover the contents under a module.</li> <li>• Students will have to answer 5 full questions, selecting one full question from each module. ■</li> </ul>			
<b>Textbook</b>			
1	Power Systems in Emergencies: From Contingency Planning to Crisis Management	U. G. Knight	Wiley
			1 <sup>st</sup> Edition, 2001

<b>B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VIII</b>			
<b>INTERNSHIP / PROFESSIONAL PRACTICE</b>			
Subject Code	15EE84	IA Marks	50
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	50
<b>Credits - 02</b>			
<b>Course objectives:</b>			
<p>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,</p> <ul style="list-style-type: none"> <li>• To put theory into practice.</li> <li>• To expand thinking and broaden the knowledge and skills acquired through course work in the field.</li> <li>• To relate to, interact with, and learn from current professionals in the field.</li> <li>• To gain a greater understanding of the duties and responsibilities of a professional.</li> <li>• To understand and adhere to professional standards in the field.</li> <li>• To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.</li> <li>• To identify personal strengths and weaknesses.</li> <li>• To develop the initiative and motivation to be a self-starter and work independently. ■</li> </ul>			
<p><b>Internship/Professional practice:</b> Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.</p> <p><b>Seminar:</b> Each student, is required to</p> <ul style="list-style-type: none"> <li>• Present the seminar on the internship orally and/or through power point slides.</li> <li>• Answer the queries and involve in debate/discussion.</li> <li>• Submit the report duly certified by the external guide.</li> </ul> <p>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. ■</p>			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating, L <sub>6</sub> – Creating		
<b>Course outcomes:</b>			
<p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Gain practical experience within industry in which the internship is done.</li> <li>• Acquire knowledge of the industry in which the internship is done.</li> <li>• Apply knowledge and skills learned to classroom work.</li> <li>• Develop a greater understanding about career options while more clearly defining personal career goals.</li> <li>• Experience the activities and functions of professionals.</li> <li>• Develop and refine oral and written communication skills.</li> <li>• Identify areas for future knowledge and skill development.</li> <li>• Expand intellectual capacity, credibility, judgment, intuition.</li> <li>• Acquire the knowledge of administration, marketing, finance and economics. ■</li> </ul>			
<b>Graduate Attributes (As per NBA):</b>			
<p>Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.</p>			

**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>B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VIII</b>			
<b>PROJECT WORK PHASE -II</b>			
Subject Code	15EEP85	IA Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	100
<b>Credits - 06</b>			
<b>Course objectives:</b>			
<ul style="list-style-type: none"> <li>• To support independent learning.</li> <li>• To guide to select and utilize adequate information from varied resources maintaining ethics.</li> <li>• To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.</li> <li>• To develop interactive, communication, organisation, time management, and presentation skills.</li> <li>• To impart flexibility and adaptability.</li> <li>• To inspire independent and team working.</li> <li>• To expand intellectual capacity, credibility, judgement, intuition.</li> <li>• To adhere to punctuality, setting and meeting deadlines.</li> <li>• To instil responsibilities to oneself and others.</li> <li>• 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. ■</li> </ul>			
<b>Project Work Phase - II:</b> 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.			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating, L <sub>6</sub> – Creating		
<b>Course outcomes:</b>			
At the end of the course the student will be able to:			
<ul style="list-style-type: none"> <li>• Present the project and be able to defend it.</li> <li>• 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.</li> <li>• Habituated to critical thinking and use problem solving skills</li> <li>• Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.</li> <li>• Work in a team to achieve common goal.</li> <li>• Learn on their own, reflect on their learning and take appropriate actions to improve it. ■</li> </ul>			
<b>Graduate Attributes (As per NBA):</b>			
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>Evaluation Procedure:</b>			
The Internal marks evaluation shall be based on project report and presentation of the same in a seminar.			
<b>Project Report:</b> 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.			
<b>Project Presentation:</b> 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. ■			
<b>Semester End Examination</b>			
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>B.E ELECTRICAL AND ELECTRONICS ENGINEERING (EEE)</b>			
<b>CHOICE BASED CREDIT SYSTEM (CBCS)</b>			
<b>SEMESTER - VIII</b>			
<b>SEMINAR</b>			
Subject Code	15EES86	IA Marks	100
Number of Practical Hours/Week	--	Exam Hours	--
Total Number of Practical Hours	--	Exam Marks	--
<b>Credits - 01</b>			
<p><b>Course objectives:</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>• Carryout literature survey, organize the Course topics in a systematic order.</li> <li>• Prepare the report with own sentences.</li> <li>• Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.</li> <li>• Present the seminar topic orally and/or through power point slides.</li> <li>• Answer the queries and involve in debate/discussion.</li> <li>• Submit typed report with a list of references.</li> </ul> <p>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. ■</p>			
<b>Revised Bloom's Taxonomy Level</b>	L <sub>3</sub> – Applying, L <sub>4</sub> – Analysing, L <sub>5</sub> – Evaluating, L <sub>6</sub> – Creating		
<p><b>Course outcomes:</b></p> <p>At the end of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• Attain, use and develop knowledge in the field of electrical and electronics engineering and other disciplines through independent learning and collaborative study.</li> <li>• Identify, understand and discuss current, real-time issues</li> <li>• Improve oral and written communication skills</li> <li>• Explore an appreciation of the self in relation to its larger diverse social and academic contexts.</li> <li>• Apply principles of ethics and respect in interaction with others. ■</li> </ul>			
<p><b>Graduate Attributes (As per NBA):</b> Engineering Knowledge, Problem Analysis, Design / development of solutions, Conduct investigations of complex Problems, Modern Tool Usage, Engineers and society, Environment and sustainability, Ethics, Individual and Team work, Communication.</p>			
<p><b>Evaluation Procedure:</b> 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.</p> <p><b>Marks distribution for internal assessment of the course 15EES86 seminar:</b> Seminar Report: 30 marks Presentation skill:50 marks Question and Answer:20 marks. ■</p>			

