SYLLABUS
(WITH EFFECT FROM 2018-19)

VII to VIII Semester
Bachelor Degree
In
Electrical & Electronics Engineering

OUT COME BASED EDUCATION
WITH
CHOICE BASED CREDIT SYSTEM

P.E.S. College of Engineering
Mandya - 571 401, Karnataka
(An Autonomous Institution Affiliated to VTU, Belagavi)
Grant -in- Aid Institution
(Government of Karnataka)
Accredited by NBA, New Delhi
Approved by AICTE, New Delhi.

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Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running Eight undergraduate and Eight Postgraduate programs. It consists of Six M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome

Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted the CBCS based semester structure with OBE scheme and grading system.

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

Choice Based Credit System (CBCS) provides choice for students to select from the prescribed courses (core, Foundation, Foundation Elective, elective, open elective and minor or soft skill courses). The CBCS provides a 'cafeteria' type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach to learning which enables integration of concepts, theories, techniques, and, perspectives from two or more disciplines to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline. These greatly enhance the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of the academic year 2015-16. Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are included in all undergraduate programs.

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Deputy Dean (Academic)
Associate Professor,
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P.E.S.COLLEGE OF ENGINEERING, MANDYA-571 401
(An Autonomous Institution under VTU, Belagavi)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Profile

Department of Electrical & Electronics Engineering Programme has been accredited by NBA for 6 Academic years (2017-18 to 2022-23).

The Department of Electrical and Electronics Engineering was established right from the inception of the institute in the year 1962. The various programs offered by the

Department are B.E., M.Sc., (Engg.) by research and research leading Ph.D affiliated to Visvesvaraya Technological University (VTU), Belagavi. Also, Department is affiliated for Ph.D program with University of Mysore, Mysore and Kuvempu University, Shimoga. About 100 research papers have been published by the Department faculty members in various International & National journals and conferences.

The Department emphasizes towards imparting quality education, rigorous teaching-learning, hands-on expertise and helping students to shape their all-round personality. The Department with its strong pool of faculty, well-developed laboratories, latest software and hardware facilities, contributes to develop life-long learning skills to its students and producing worthy researchers by offering doctoral research program.

The academic programs are designed and updated keeping in view the constantly changing industrial needs, skills and challenges emerging out of new research. The academic programs are well received by the industry and academia. The department has always exerted the best of its effort to meet the objectives of achieving technical excellence in the areas of Electrical and Electronics Engineering such as High Voltage Engineering, Power Electronics & Drives, Control Systems, Power Systems, Energy Systems, Analog and Digital Electronics, Signal Processing, PLC & SCADA and Microcontrollers

The Department regularly organizes industrial visits, Technical lectures by experts from industries and institutes in contemporary areas to bridge the gap between syllabi and current developments.

VISION

The department of E & E would endeavour to create a pool of Engineers who would be technically competent, ethically strong also fulfill their obligation in terms of social responsibility.

MISSION

- Adopt the best pedagogical methods and provide the best facility, infrastructure and an ambience conducive to imbibe technical knowledge and practicing ethics.
- Group and individual exercises to inculcate habit of analytical and strategic thinking to help the students to develop creative thinking and in still team skills.
- MOUs and Sponsored projects with industry and R & D organizations for Collaborative learning
- Enabling and encouraging students for continuing Education and moulding them for life-long learning process

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Excel in professional career and/or higher education by acquiring knowledge in mathematical, computing and Electrical & Electronics engineering principles

PEO2: Analyze real life problems and Design Electrical & Electronics Engineering system with appropriate solutions that are technically sound, economically feasible and socially acceptable

PEO3: Exhibit professionalism, ethical attitude, communications kills, team work in their profession and adapt to current trends by engaging in lifelong learning.

PROGRAMME OUTCOMES (POs)

PO-1: Graduates will apply the knowledge of mathematics, Physics, chemistry and allied engineering subjects to solve problems in Electrical and Electronics Engineering.

PO-2: Graduates will Identify, formulate and solve Electrical and Electronics Engineering problem.

PO-3: Graduates will design Electrical and Electronics systems meeting the given specifications for different problems taking safety and precautions into consideration.

PO-4: Graduates will design, conduct experiments, analyze and interpret data

PO-5: Graduates will use modern software tools to model and analyze problems, keeping in view their limitations.

PO-6: Graduates will understand the impact of local and global issues / happenings on Electrical Engineers.

PO-7: Graduates will provide sustainable solutions for problems related to Electrical and Electronics Engineering and also will understand their impact on environment.

PO-8: Graduates will have knowledge of professional ethics and code of conduct as applied to Electrical Engineers.

PO-9: Graduates will work effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PO-10: Graduates will communicate effectively in both verbal and written form.

PO-11: Graduates will plan, execute and complete projects

PO-12: Graduates will have the ability for self- education and lifelong learning

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: To understand the concept in Electrical and Electronics Engineering and apply them to develop modules analyze assess the performance of various power system equipment, generation, transmission, utilization and protection mechanisms.

PSO2: Design, develop, analyze and test electrical and electronics system: Deploy control strategies for electrical dives, power system networks, power electronics, high voltage and other related applications.

VII Semester B.E Electrical & Electronics Engineering

Sl. No.	Course Code	Course Title	Teaching Department	Hrs. / Week			Credits	Examination Marks		
				L	T	P		CIE	SEE	Total
1	P18EE71	Computer Techniques In Power System	EE	4	-	-	4	50	50	100
2	P18EE72	High Voltage Engineering	EE	4	-	-	4	50	50	100
3	P18EE73	AC & DC Drives	EE	4	-	-	4	50	50	100
4	P18EE74X	Professional Elective – III	EE	2	2	-	3	50	50	100
5	P18EE75X	Open Elective – II	EE	3	-	-	3	50	50	100
6	P18EEL76	High Voltage laboratory	EE	-	-	3	1.5	50	50	100
7	P18EEL77	Power system simulation laboratory	EE	-	-	3	1.5	50	50	100
8	P18EE78	Project Work Phase – I and Project seminar	EE	-	-	4	2	100	-	100
Total							**23**	**450**	**350**	**800**

List of Electives

Professional Elective – III			Open Elective – II		
Sl. No	**Course Code**	**Course title**	**Sl. No.**	**Course Code**	**Course title**
1.	P18EE741	Flexible AC Transmission Systems	1.	P18EE O751	Utilization of Electrical Power
2.	P18EE742	Testing & Commissioning of Electrical Equipment	2.	P18EEO752	Renewable Energy Sources
3.	P18EE743	Electrical Power Utilization	3.	P18EEO753	Hybrid Electric Vehicles
4.	P18EE744	Artificial Neural Network and Artificial Intelligence	4.	P18EEO754	Automation Engineering

VIII Semester B.E Electrical & Electronics Engineering

Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week			Credits	Examination Marks		
				L	T	P		CIE	SEE	Total
1	P18EE81	Renewable Energy Sources	EE	4	-	-	4	50	50	100
2	P18EE82X	Professional Elective – IV	EE	2	2	-	3	50	50	100
3	P18EE83	Internship	EE			-	2	50	50	100
4	P18EE84	Project Work Phase – II	EE	-	-	-	6	100	100	200
5	P18EE85	Self-study course & Seminar (Any advanced program discipline open source courses)	EE	-	-	4	2	50	-	50
Total							**17**	**300**	**250**	**550**

Professional Elective – IV

Sl. No	Course Code	Course title
1.	P18EE821	HVDC Power Transmission
2.	P18EE822	Energy Auditing & Demand Side Management
3.	P18EE823	Power system operation and control
4.	P18EE824	Smart Grid

Course Title: Computer Techniques In Power Systems			
Course Code: P18EE71	**Semester: VII**	**L.T.P.H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture:52Hrs, Exam 3 Hrs		**Weightage: CIE:50%SEE:50%**	

Prerequisites: The student should have undergone the course on Power system Analysis, transmission and distribution and A.C. machines

Course Learning Objectives (CLOs)

This course aims to:

1. Form the bus admittance matrix for the given power system network by singular transformation method.
2. Develop general power flow equations (PFE) or Load flow analysis (LF) equations for an n-bus power system.
3. Solve PFE (LFA) using algorithms such as Gauss-Seidel and Newton-Raphson methods.
4. Analyze or Design a power system for a given operation conditions.
5. To allocate the total demand of a power system by optimizing the overall operating costs.
6. Determine the transient stability of a power system.

Relevance of the Course

This course covers the analysis of large power systems by using computers. For large power system networks, it is not possible use conventional methods that employ manual calculations. Hence, it is necessary to go for the computer oriented techniques which are based on numerical methods. In this course students are thought how to do Load flow analysis, stability analysis of power system, and perform economic operation of power system.

Course Content

Unit - I

Network Topology: Introduction, Elementary graph theory – oriented graph, tree, co-tree, basic cut sets, basic loops; Incidence matrices – Element-node, Bus incidence, Tree-branch path, Basic cut-set, Augmented cut-set, Basic loop and Augmented loop matrices; Primitive networks – impedance form and admittance form. **10 Hrs**

Self-study: program to calculate incidence matrices using software

Unit - II

Network Matrices: Introduction, Formation of Y_{bus} – by method of inspection, by method of singular transformation (YBUS = At[y]A); Formation of Bus Impedance Matrix with(3x3) and without mutual coupling elements. Problems on Y_{bus} and Z_{bus} formation **10 Hrs**

Self-study: Program to form Ybus and Zbus matrices.

Unit – III

Load Flow Studies: Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow, Gauss - Seidal Method – Algorithm and flow chart for PQ and PV buses (numerical problem for one iteration only), Acceleration of convergence; Newton Raphson Method – Algorithm and flow chart for NR method in polar coordinates (numerical problem for one iteration only), Decoupled load flow, Fast Decoupled Load flow (Excluding Problems), Comparison of load flow studies. **12 Hrs**

Self-study: Program for power flow studies using software

Unit - IV

Economic Operation of Power System: Introduction, Performance curves, Economic Generation Scheduling neglecting losses and generator limits, Economic Generation Scheduling including generator limits and neglecting losses, Economic Dispatch including transmission losses – penalty factor, Derivation of transmission loss formula.

10Hrs

Self-study: Iterative technique to solve economic dispatch problems.

Unit-V

Transient Stability Studies: Equal Area Criterion, Swing equation, Numerical solution of Swing Equation – Point-by-point method, Modified Euler's method, Runge -Kutta method, Milne's predictor corrector method, Representation of power system for transient stability studies.

10 Hrs

Self-study: Program for Power-angle equation using software

Text Books:

1. "Computer Methods in Power System Analysis", by: Stagg, G.W, and EI-Abiad A.H McGraw Hill International Student Edition. 1988.
2. "Computer Techniques and Models in Power Systems", by: K.UmaRao,I.K (Interline) International publishing House Pvt. Ltd, 2015

Reference Books:

3. Modern Power System Analysis, by :Kothari, D. P., and Nagrath, I. J., TMH, 4th - Edition, 2014

Course Outcomes

After learning all the units of the course, the student is able to

CO1: Apply the network topology to obtain different types of incidence matrices.

CO2: Apply the different methods to construct network matrices-Y bus and Z bus.

CO3: Examine load flow studies using different algorithms.

CO4: Analyze the economic generation schedule considering pre-specified constraints

CO5: Analyze the transient stability of a power system using a variety of techniques.

Course Articulation Matrix															
Course Outcome (CO)		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of network topology to obtain different types of incidence matrices.	3	3	-	-	-	-	-	-	-	-	-	-	2	-
2	Apply the different methods to construct network matrices-Y bus and Z bus.	3	3	-	-		-	-	-	-	-	-	-	2	
3	Examine load flow studies using different algorithms.	3	3	-	-	2	-	-	-	-	-	-	-	2	
4	Analyze the economic generation schedule considering pre-specified constraints	3	3	-	-	-	-	-	-	-	-	-	-	2	
5	Analyze the transient stability of a power system using a variety of techniques.	3	3	-	-	2	-	-	-	-	-	-	-	2	-
3-High		**2-Medium**												**1-Low**	

Course Title: High Voltage Engineering			
Course Code: P18EE72	**Semester: VII**	**L-T-P-H: 4-0-0-4**	**Credits – 4**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50% SEE:50%**	

Prerequisites: The student should have undergone the course on High Voltage Engineering

Course Learning Objectives

1. Students will understand the Breakdown phenomenon in gaseous, solids and liquid Dielectrics.
2. Students will learn basic need to generate high voltages such as HVAC, HVDC, Impulse Voltages and Impulse Currents in the laboratory.
3. Students gain the fundamental knowledge of physical phenomena of breakdown in insulating media and students will know the importance of insulating media and their applications in various fields.
4. Students will learn how to measure the high voltages in the laboratory
5. Students will know importance of testing and learn procedure of testing different insulating media for accessing their condition

Course Content

Unit-I

Introduction: Introduction to HV technology, Need for generating high voltages in laboratory. Important applications of high voltage.

Breakdown phenomena: Classification of HV insulating media. Gaseous dielectrics: Ionizations, primary and secondary ionization processes. Criteria for gaseous insulation breakdown - Townsend's theory, limitations of Townsend's theory, Streamer's theory, Breakdown in non-uniform fields, Corona discharges, , Paschen's law and its significance, Time lags of Breakdown. Breakdown in solid dielectrics- Intrinsic breakdown, Avalanche breakdown, Thermal breakdown and Electro-mechanical breakdown. Breakdown of liquids dielectrics- Suspended particle theory, Electronic breakdown, Cavity breakdown (bubble's theory). **11Hrs**

Self-Study: Breakdown in electro-negative gases

Unit-II

Generation of HVAC and HVDC Voltages: HVAC - HV transformer; Need for cascade connection and working of transformer units connected in cascade, Series resonant circuit, Tesla coil. HVDC -, Cockcroft- Walton type high voltage DC set. Regulation, Ripple and Optimum number of stages.

Self-Study: Voltage doubler circuit **10Hrs**

Unit-III

Generation of Impulse Voltage and Current: Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage, Multistage impulse generator - working of Marx impulse generator, Rating of impulse generator, Components of multistage impulse generator, Triggering of impulse generator by Trigatron gap, Generation of switching impulse voltage, Generation of high impulse current. **10Hrs**

Self-Study: Triggering of impulse generator by three electrode gap arrangement

Unit-IV

Measurement of High Voltages: Electrostatic voltmeter - principle, construction and limitation; Chubb and Fortescue method for HVAC measurement, Generating voltmeter-Principle & Construction; Series resistance micro ammeter for HVDC measurements,

Standard sphere gap measurements for HVAC, HVDC and Impulse voltages; Factors affecting the measurements: Potential dividers - Resistance dividers, Capacitance dividers , Mixed RC potential dividers;

Self-Study: Surge current measurement - Klydanograph and Magnetic link.

11Hrs

Unit-V

Non-destructive Insulation Testing Techniques: Dielectric loss and loss angle measurements using Schering Bridge, Transformer ratio arms bridge; Need for discharge detection, PD measurements – aspects, factors affecting the discharge detection; Discharge detection methods - Straight and Balanced methods.

High Voltage Tests on Electrical Apparatus: Tests on Circuit breakers and Transformers.

10Hrs

Self-Study: Tests on Cables and Insulators

Text Books:

1. High Voltage Engineering Fundamentals- E. Kuffel and W.S. Zaengl, Elsevier press, - 2nd Edition, 2005.

2. High Voltage Engineering- M.S.Naidu and Kamaraju, THM, - 3rd Edition,2007.

Reference books:

1. High Voltage Engineering - C.L.Wadhwa, New Age International Private limited, 1995.

2. Extra High Voltage AC Transmission Engineering -Rakosh Das Begamudre, Wiley Eastern limited, 1987.

3. High Voltage Technology- L. L. Alston- BSB Publication, 1st Edition, 2008.

Course Outcomes (CO)

After learning all the units of the course, The Students will be able to

CO1: Apply the knowledge of the Phenomena of Breakdown in different Dielectrics

CO2: Analyze the HVAC and HVDC voltage generation processes

CO3: Examine the concepts regarding generation of HVAC, HVDC, and impulse voltages.

CO4: Illustrate how HVAC, HVDC, and impulse voltages are measured.

Voltage Tests on Electrical Apparatus.

CO5: Analyze the concepts of Non-destructive Insulation Testing Techniques and High

Course Articulation Matrix														
	Program outcomes													
Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Apply the knowledge of the Phenomena of Breakdown in different Dielectrics	3	2	-	-	-	1	-	-	-	-	-	-	-	2
Analyze the HVAC and HVDC voltage generation processes	2	2	-	-	-	-	-	-	-	-	-	-	-	2
Examine the concepts regarding generation of HVAC, HVDC, and impulse voltages.	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Illustrate how HVAC, HVDC, and impulse voltages are measured.	2	2	-	-	-	-	-	-	-	-	-	-	1	2
Analyze the concepts of Non-destructiveInsulation Testing Techniques and High Voltage Tests on Electrical Apparatus.	3	2	-	-	-	2	-	-	-	-	-	-	1	2
1 – Low			**2 – Moderate**										**3 – High**	

Course Title: AC and DC Drives			
Course Code: P18EE73	**Semester: VII**	**L-T-P-H: 4-0-0-4**	**Credits : 4**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage: CIE:50% SEE:50%**	

Course Learning Objectives:

1. To study and understand the basics of drive system and their control with their operating regions.
2. To learn the operating principles of different types of drive systems and their speed control like dc shunt/separately excited motor drive system using single phase & three phase controlled rectifiers.
3. To learn the operating principle, performance characteristics and speed control of induction motor drive system, synchronous motor drive system.
4. To understand the principles of some energy recovery schemes for performance improvement of IM drive system.
5. To understand the various processes in manufacturing industries and the different types of motors used in different stages.
6. Design and analyze simple drive systems and also to carry out mini-project in teams for a given set of specifications.

Course Content

Unit – I

Introduction: Electric Drives, Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drives, Status of DC &AC Drives.

Rectifier controlled dc drives: Speed torque characteristics, speed control techniques of shunt/separately excited dc motor (theory only), Half & Fully controlled rectifier fed dc drives, (separately &series dc motors) under continuous and discontinuous current mode, Ward Leonard drives**.** **10Hrs**

Self-study: Controlled rectifier fed dc drives

Unit – II

Converter fed Drives: Three phase half controlled rectifier control of dc separately exited motor,

,Three phase fully controlled rectifier control of dc separately exited motor converter fed dc drives, dual converter fed drives, multi quadrant operation of dc separately exited motor fed from fully controlled rectifier.

Chopper controlled dc drives: Chopper controlled dc drives – Chopper Control Of Separately exited Dc motor,(motoring and braking operation, multi-quadrant operation of chopper)Chopper control of series motor(motoring and braking operation)**.**

10Hrs

Self-study: Control of fractional HP motor.

Unit – III

Closed loop control of DC Drives: Introduction, Open loop transfer function, closed loop transfer function, closed loop position control, Phase locked loop, Microcomputer control of DC drives.

Concept of dc motor braking: Methods of braking - regenerative, dynamic braking & plugging

Self-study: Closed loop speed control of Multi-motor drivers **10Hrs**

Unit – IV

AC Drives: Introduction to three phase Induction Motor drives, Analysis and Performance, Speed and Torque control methods: Stator voltage control, rotor voltage control, Stator frequency control, Voltage and frequency control, VSI fed IM drive, closed loop speed control and converter rating for VSI and Cycloconverter Induction motor drives, CSI fed IM drive, closed loop control of CSI drives, Static Kramer drive, Static Scherbius drive and braking of IM. **12Hrs**

Self-study: Eddy current drives

Unit – V

Synchronous motor Drives: Introduction, Variable frequency control, Self-controlled synchronous motor employing load commutated thyristor inverter and cycloconverter.

Industrial drives: Rolling mill drives, Textile mill drives , Cement mill drives, Paper mill drives.

Self-study: Starting large synchronous machines. **10Hrs**

Text Books:

1. "Electric drives" by G.K Dubey, Narosa publishing house, second Edition 2011.
2. 2."A first course in Electric Drives", S K Pillai, Wiley Eastern ltd, 1990

Reference Books:

1. "Thyristor control of electric Drives",V. Subramanyam, Tata McGraw Hill, second Edition 2007.
2. "Power Semiconductor Drives", S. Sivanagaraju, PHI publications,1st Edition,2008
3. "Power electronics", M.H Rashid, PHI, third edition 2012.
4. Power Electronics: Principles and Applications, Joseph Vithayathil, Publisher(s):McGraw-Hill College,1995

Course Outcomes:

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

1. Analyze the various types of electric drives with their operating characteristics.
2. Analyze the various types of converter and chopper fed drives for different quadrant operation.
3. Describe the concepts of open and closed loop drives to assess the braking operation of Induction motor.
4. Apply different methods of speed control for induction motor drive.
5. Analyze various motor drive control scheme for industrial applications

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	Apply the knowledge of power electronics to study the operating characteristics of electric drives	3	2	-	-	-	-	-	-	-	-	-	2		2
2	Analyze the various types of converter and chopper fed drives for different quadrant operation.	2	3	-	-	-	-	-	-	-	-	-	-	-	2
3	Analyze the braking operation of open and closed loop drives	2	3	-	-	-	-	-	-	-	-	-	-	-	2
4	Apply different methods of speed control for induction motor drive.	3	2	-	-	-	-	-	-	-	-	-	-		2
5	Analyze various motor drive control scheme for industrial applications.	2	3	-	-	-	-	-	-	-	-	-	-	-	2
1-Low		**2-Medium**											**3-High**		

Course Title: Flexible AC Transmission Systems (FACTS)			
Course Code: P18EE741	**Semester: VII**	**L-T-P-H: 2-2-0-4**	**Credits – 3**
Contact period : Lecture: 52Hrs, Exam 3 Hrs	**Weightage : CIE:50 SEE:50**		

Course Content

Unit – I

FACTS Concepts and General System Configuration: Transmission interconnection, Power flow in AC system, Power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters, Basic types and Brief Description of FACTS Controller. **12Hrs**

Self-study: Benefits from FACTS

Unit – II

Voltage sourced converters: Basic concepts, single phase full wave bridge converter operation, single phase-Leg operation, Square wave voltage harmonics for a single phase bridge, Three phase full wave bridge converter, Transformer connection for 12 Pulse Operation. **10Hrs**

Self-study: Transformer connection for 24 pulse operation

Unit – III

Self and Line Commutated Current Source Converter: Basic concepts, 3-phase full wave diode rectifier, Thyristor based converter; rectifier, inverter operation & commutation failures, Current sourced converter with turn-off devices, Current source versus voltage source converters. **10Hrs**

Self-Study: Diode Rectifier

Unit – IV

Static Shunt Compensator SVC and STATCOM: Objective of shunt compensation, Methods of controllable Var generation; TCR & TSR, TSC; Static Var compensator, SVC and STATCOM; VI & VQ curves & transient stability enhancement **10Hrs**

Self-study: Voltage control of SVC

Unit – V

Static Series Compensators GCSC, TSSC, TCSC and SSSC: Objectives of series compensation; capacitive compensation, transcendent stability improvement & power oscillation damping, Variable impedance type of series compensation, switching converter type series compensation; SSSC. **10Hrs**

Self-Study: The need for variable-series compensation

Text Book:

1. Narain G. Hingorani and Laszlo Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, Standard Publishers Distributors, Delhi, Publication.2013, ISBN 81-86308-79-2.

Reference Books:

1.R. MohanMathur, Static Controllers for Electrical Transmission Systems, IEEE Press and John Wiley & Sons, Inc.,2002.
2.R. MohanMathur and Rajiv K. Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, IEEE Press and John Wiley & Sons, Inc. 2010-I

Course Outcomes

CO1: Describe and analyze the Transmission, Power flow and dynamic stability in FACTS controllers.

CO2: Analyze the different types of voltage converts in FACTS

CO3: Analyze the different types of current converts in FACTS

CO4: Examine the SVC and SATCOM shunt compensators in FACTS

CO5: Examine the different series compensators in FACTS

Course Articulation Matrix

	Course Outcome – CO	**Program Outcome**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Describe and analyze the Transmission, Power flow and dynamic stability in FACTS controllers	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	Analyze the different types of voltage converts in FACTS	3	2	-	-	-	-	-	-	-	-	-	-	2	-
3	Analyze the different types of current converts in FACTS	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	Examine the SVC and SATCOM shunt compensators in FACTS	3	2	-	-	-	-		-	-	-	-	-	2	-
5	Examine the different series compensators in FACTS	3	2	-	-	-	-		-	-	-	-	-	2	-
1-Low		**2-Medium**										**3-High**			

Course Title: Testing and commissioning of Electrical Equipment			
Course Code : P18EE742	Semester : IV	L-T-P-H: 2-2-0-4	Credits – 3
Contact Period: Lecture: 52 Hrs. Exam 3 Hrs		Weightage: CIE:50 SEE:50	

Course Content

Unit-I

TRANSFORMERS: Specifications: Power and distribution transformers as per BIS standards.

Installation: Location, site, selection, foundation details (like bolts size, their number, etc), code of practice for terminal plates, polarity & phase sequence, oil tanks, drying of windings and general inspection.

Commissioning tests: Following tests as per national & International Standards, volt ratio test, earth resistance, oil strength, Bucholz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, load & temperature rise test.

Specific Tests: Determination of performance curves like efficiency, regulation etc, and determination of mechanical stress under normal &abnormal conditions. **12Hrs**

Self- study: Different types of transformer oil tanks

Unit-II

SYNCHRONOUS MACHINES: Specifications: As per BIS standards.

Installation: Physical inspection, foundation details, alignments, excitation systems, cooling and control gear, drying out.

Commissioning Tests: Insulation, Resistance measurement of armature & field windings,

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, measurements of sequence impedances, capacitive reactance, separation of losses, temperature rise test, retardation tests, Various abnormal conditions and the respective Protection

10Hrs

Self-study: Selection of motor

Unit-III

Induction Motors: Specifications for different types of motors, Duty, I.P. protection.

Installation: Location of the motors (including the foundation details) & its control apparatus, shaft & alignment for various coupling, fitting of pulleys & coupling, drying of windings.

Commissioning Test: Mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations & balancing.

Electrical Tests: Insulation test, earth resistance, high voltage test, starting up, failure to speed up to take the load, type of test, routine test, factory test and site test (in accordance with ISI code. `

Self-study: Maintenance of motor **10Hrs**

Unit-IV

SWITCH GEAR & PROTECTIVE DEVICES: Standards, types, specification, installation, commissioning tests, maintenance schedule, type & routine tests.

Current transformer and Voltage transformer: Specifications, procurement, testing of CT, Specifications, procurement, testing of PT, Specifications and testing of cable.
Self-study: Rating of circuit breakers **10Hrs**

Unit-V

Safety Management: Objectives of safety management, seven principles of safety management, work permit system , safety clearance and creepages, Safety procedures in eclectic plant, First aid, Electric shock, touch potential and step potential, recommended safety precautions against electric shock in small buildings, shops, and small LV installations Live line working (Hot line Maintenance), safety management during O and M. **10Hrs**
Self-study: First aid

TEXT BOOKS:

1. Testing & Commissioning Of Electrical Equipment -S.S. Rao,TMH,1st Edition,1990
2. Testing & Commissioning Of Electrical Equipment -Ramesh L. Chakrasali, Elite Publication.

REFERENCE BOOKS:

1. Relevant Bureau of Indian Standards
2. "A Handbook on Operation and Maintenance of Transformers"-H. N. S. Gowda, Transformer & Switch Gear Handbook-Transformers-BHEL, J &P, J & P

Course Outcomes

CO1: Examine the specifications, installation procedure, and commissioning process of transformers

CO2: Analyze the specification, installation procedure and commissioning process of synchronous machine.

CO3: Analyze the specification, coupling and alignment process of Induction motor for installation.

CO4: Analyze and test the protective devices for CT and PT**.**

CO5: Illustrate the safety management and safety measures.

Course Articulation Matrix																
Course Outcomes		**Program Outcomes**														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Examine the specifications, installation procedure, and commissioning process of transformers	2	2	-	-	-	-	-	-	-	-	-	-	-	2
2	Analyze the specification, installation procedure and commissioning process of synchronous machine.	2	2	-	-	-	-	-	-	-	-	-	-	-	2
3	Analyze the specification, coupling and alignment process of Induction motor for installation	2	2	-	-	-	-	-	-	-	-	-	-	-	2
4	Analyze and test the protective devices for CT and PT	2	2	-	-	-	2	-	-	-	-	-	-		2
5	Illustrate the safety management and safety measures	2	2	-	-	-	3	-	-	-	-	-	-		2
1-Low **2-Medium** **3-High**																

Course Title: Electrical Power Utilization			
Course Code: P18EE743	**Semester: VII**	**L-T-P-H: 2-2-0-4**	**Credits – 3**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage: CIE:50 SEE:50**	

Course Content

Unit – I

Heating and Welding: Introduction, mode of heat transfer, advantages and methods of electric heating, resistance heating, induction heating, the arc furnaces, vertical core type furnace, Indirect core type furnace, Induction furnace, coreless Induction furnace, Dielectric heating, electric welding and their types. **12Hrs**

Self-Study: Control device and electric equipment

Unit – II

Illumination: Laws of illumination, light schemes, Design of lighting scheme, different types of lamps, construction and working of Incandescent, sodium vapour lamp, mercury vapour lamp, fluorescent lamp, and CFL and LED **10Hrs**

Self-Study: Recommended levels of Illumination

Unit – III

Electric Traction: Introduction, requirement of an ideal traction system scheme of traction and merits and demerits, types of electric traction, electric trains, tramways , trolley buses, systems of electrification for traction purposes: direct current, 1 phase AC system, Three phase as system, composite system. **10Hrs**

Self-Study: Diesel electric traction

Unit – IV

Speed-Time Characteristics: Analysis of speed-time curve for electric train, Mechanism of train movement , tractive effort for propulsion of train, specific energy output, various factors affecting energy consumption **10Hrs**

Self-Study: Types of railway systems

Unit – V

Traction Motors: Introduction, selection of traction motors, methods of speed control - energy saving by series-parallel method, AC series motor, characteristics, electric braking-plugging, rheostatic braking, regenerative breaking on A C series motor **10Hrs**

Self-Study: linear induction motor and their use.

Text Books:

1. Electrical Power systems by Dr. S.L. Uppal, Prof. S Rao , Khanna Publishers,15th edition, 2011
2. Power System Engineering by A Chakrabarti M.L. Soni , P.V. Gupta Bhatnagar, DhanpatRai& Co (pvt) Ltd., 2013
3. Utilization of Electrical power by R K Rajput, Laxmi publication

Reference books:

1. Utilization of Electric Energy-Openshaw Taylor, University Press,3rd Edition,2009.
2. Utilization of Electrical power by Dr. Ramesh L Chakrasali, 2014

Course Outcomes

After learning all the units of the course, the student is able to:

CO1: Discuss different types of heating and welding

CO2: Describe different Lighting scheme and types of lamps.

CO3: Analyze different schemes, types and applications of Electric traction.

CO4: Analyze the speed-time characteristics of Electric train

CO5: Analyze the different traction motors and their applications.

Course Articulation Matrix													
Course Outcomes		Program Outcomes											
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	Discuss different types of heating and welding	2	-	-	-	-	-	-	-	-	-	-	2
2	Describe different Lighting scheme and types of lamps.	2	-	-	-	-	-	-	-	-	-	-	2
3	Analyze different schemes, types and applications of Electric traction.	2	3	-	-	-	-	-	-	-	-	-	2
4	Analyze the speed-time characteristics of Electric train	2	3	-	-	-	-	-	-	-	-	-	2
5	Analyze the different traction motors and their applications.	2	3	-	-	-	-	-	-	-	-	-	2
1-Low		**2-Medium**									**3-High**		

Course Title: Artificial Neural Networks & Artificial Intelligence			
Course Code: P18EE744	**Semester: VII**	**L-T-P-H: 2-2-0-4**	**Credits – 3**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50% SEE:50%**	

Course Learning Objectives (CLOs)

This course aims is to:

1. Understand the different terminologies used in Artificial Neural Network.
2. Study the different learning rules in ANN.
3. Understand the architecture and algorithm of various neural networks.

Course Content

Unit-I

Introduction to ANN:

Human Brain, Biological Neuron networks –Artificial Neural networks (ANN). Comparison between ANN and Biological Neuron networks. Architectures- Feed forward and Feedback architecture. Supervised, Unsupervised and Reinforcement leaning. ANN terminologies: Weights, Activation functions-Sigmoidal functions, Bias, Threshold.

Fundamental models of ANN & Learning Processes:

McCulloch-Pitts (MP) neuron model – Architecture (MP model on AND and OR gates only). Learning rules: Hebbian learning rule, Perception Learning rules, delta Learning rules, Competitive learning, Boltzmann learning, Memory-based learning.

Self-Study: Generate AND, NOT function using MP neural net by MATLAB. **11 Hrs**

Unit-II

Architecture and Algorithms of ANN:

Hebb net – architecture, algorithm (Excluding problems)**, Perceptron Networks-** Single Layer Perceptron:**A**rchitecture, algorithm, Application procedure. Perceptron algorithm for several output classes (Excluding problems). Brief introduction to Multi-Layer Perceptron networks.

Adaline and Madline networks- Adaline networks-Architecture, algorithm, Application procedure (Excluding problems) and Madline networks Architecture, algorithm, and Application procedure (Excluding problems).

Self-Study: Develop MATLAB program for AND & OR function by using perceptron and adaline net.

10Hrs

Unit-III

Feedback networks: Discrete Hopfield Net –architecture, training algorithm, application algorithm, analysis. Continuous Hopfield Net.Bi-directional Associative Memory (BAM)(Excluding problems).Relation between BAM & Hopfield Net.

Feed forward networks: Introduction, Back Propagation Network (BPN), - Generalized Delta learning rule (or) Back Propagation rule-Architecture, training algorithm, selection parameters, learning in Back Propagation (Excluding problems). Merits and Demerits of Back Propagation Network (BPN), Applications. Radial-Basic Function Networks (RBFN):Architecture,Trainingalgorithm for a RBFN (Excluding problems).

Self-Study: Develop a MATLAB program for approximating a two 2-dimensional functions using back propagation in batch mode.

11Hrs

Unit-IV

Self-organizing feature Map (SOM): Kohonen Self-organizing feature Map (SOM)-Architecture, training algorithm (Excluding problems). Learning vector quantization (LVQ) - Architecture, training algorithm (Excluding problems).

Adaptive Resonance Theory (ART): ART fundamentals, Basic architecture, Basic operation, Learning in ART. Basic training steps. ART1 - Architecture, training algorithms (Excluding problems).

Self-Study:ART2 - Architecture, training algorithms **10Hrs**

Unit-V

Introduction to Artificial Intelligence:

Artificial Intelligence, Goals of AI, AI Technique, Applications of AI, Types of Intelligence, Working of Speech and Voice Recognition Systems, AI - Agents & Environments, Agent Terminology, Types of Agents- Rational Agent, Simple and Model based Reflex Agents, Goal Based Agents, Utility Based Agents, Properties of Environment, different AI- Search Terminology (Meaning only).

Artificial Intelligence – Robotics:

Robotics, Robot Locomotion- Legged Locomotion, Wheeled Locomotion, Slip/Skid Locomotion, Components of a Robot, Applications of Robotic

Self-Study: Brute-Force Search Strategies, Informed (Heuristic) Search Strategies**10Hrs**

Text books:

1. “Introduction to Artificial Neural networks” .By: S N Sivanandum, S Sumathi& S N Deepa. Tata McGraw Hill publications.Year-2014

2.“Principals of Soft-computing” – By: S N Shivanadum, & S N Deepa. Wiley Eastern (India) Ltd. - publication.Year- 2013.

3. Stuart Russel, Peter Norvig "AI - A Modern Approach", 2nd Edition, Pearson Education 2007

4. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007

Reference books:

1. “Neural Networks and Fuzzy Systems”, by: Bart Kosko. PHI - publications.Year-2014.

2. Artificial Intelligence: The Basics 1st Edition by by Kevin Warwick.
3. Artificial Intelligence: Foundations of Computational Agents, 2nd Edition*By* David L. Poole and Alan K. Mackworth

Course outcomes

After completion of this course students shall be well versed with the following information:

CO1: Apply the knowledge of allied engineering to analyze the different terminologies used in Artificial Neural Network

CO2: Analyze the different learning rules in Artificial Neural Network.

CO3: Examine the architecture and algorithm of various neural networks.

CO4: Apply the knowledge of feedback and feed forward network to analyze architecture and algorithm back propagation and Hopfield networks.

CO5: Analyze the architecture and algorithm of Learning vectors and self organizing maps.

Course Articulation Matrix

Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of allied engineering to analyze the different terminologies used in Artificial Neural Network	3	3	-	-	-	-	-	-	-	-	-	-	-	-
2	Analyze the different learning rules in Artificial Neural Network.	2	3	-	-	-	-	-	-	-	-	-	-	-	-
3	Examine the architecture and algorithm of various neural networks.	2	3	-	-	-	-	-	-	-	-	-	-	-	-
4	Apply the knowledge of feedback and feed forward network to analyze architecture and algorithm back propagation and Hopfield networks.	3	3	-	-	-	-	-	-	-	-	-	-	-	-
5	Analyze the architecture and algorithm of Learning vectors and self organizing maps.	2	3	-	-	-	-	-	-	-	-	-	-	-	-

1-Low **2-Medium** **3-High**

Course Title: : Utilization of Electrical Power			
Course Code: P18EEO751	**Semester : VII**	**L-T-P-H: 3-0-0-3**	**Credits:03**
Contact Period: Lecture: 52 Hrs. Exam: 3 Hrs		**Weightage: CIE:50%**	**SEE:50%**

Course Learning Objectives (CLOs)

This course aims is to:

1. Understand the different types of heating and welding
2. Understand the different Lighting scheme and types of lamps.
3. To study about Electric traction
4. To get the knowledge of speed-time characteristics of Electric train.

Course Content

Unit – I

Heating and Welding: Introduction, mode of heat transfer, advantages and methods of electric heating, resistance heating, induction heating, the arc furnaces, vertical core type furnace, Indirect core type furnace, Induction furnace, coreless Induction furnace, Dielectric heating, electric welding and their types. **11Hrs**

Self-Study: Control device and electric equipment**.**

Unit – II

Illumination: Laws of illumination, light schemes, Design of lighting scheme, different types of lamps, construction and working of Incandescent, sodium vapour lamp, mercury vapour lamp, fluorescent lamp, and CFL.

10HrsSelf Study: Recommended levels of Illumination

Unit – III

Electric Traction: Introduction, requirement of an ideal traction system scheme of traction and merits and demerits, types of electric traction, electric trains, tramways, trolley buses, systems of electrification for traction purposes: direct current, 1 phase AC system, three phase as system, composite system. **11Hrs**

Self-Study: Diesel electric traction

Unit – IV

Speed-Time Characteristics: Analysis of speed-time curve for electric train, Mechanism of train movement , tractive effort for propulsion of train, specific energy output, various factors affecting energy consumption **10Hrs**

Self-Study: Types of railway systems

Unit – V

Traction Motors: Introduction, selection of traction motors, methods of speed control - energy saving by series-parallel method, AC series motor, characteristics, electric braking-plugging, rheostatic braking, regenerative breaking on A C series motor

Self-Study: linear induction motor and their use. **10Hrs**

Text Books:

1. Electrical Power systems by Dr. S.L. Uppal, Prof. S Rao , Khanna Publishers,15th edition, 2011
2. Power System Engineering by A Chakrabarti M.L. Soni , P.V. Gupta Bhatnagar, DhanpatRai& Co (pvt) Ltd., 2013
3.Utilization of Electrical power by R K Rajput, Laxmipublication

Reference books:

3. Utilization of Electric Energy-Openshaw Taylor, University Press,3rd Edition,2009.
4. Utilization of Electrical power by Dr. Ramesh L Chakrasali, 2014

Course Outcomes

After learning all the units of the course, the student is able to:

CO1: Discuss different types of heating and welding

CO2: Describe different Lighting scheme and types of lamps.

CO3: Analyze different schemes, types and applications of Electric traction.

CO4: Analyze the speed-time characteristics of Electric train

CO5: Analyze the different traction motors and their applications.

Course Articulation Matrix

Course Outcomes		Program Outcomes											
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	Discuss different types of heating and welding	2	-	-	-	-	-	-	-	-	-	-	2
2	Describe different Lighting scheme and types of lamps.	2	-	-	-	-	-	-	-	-	-	-	2
3	Analyze different schemes, types and applications of Electric traction.	2	3	-	-	-	-	-	-	-	-	-	2
4	Analyze the speed-time characteristics of Electric train	2	3	-	-	-	-	-	-	-	-	-	2
5	Analyze the different traction motors and their applications.	2	3	-	-	-	-	-	-	-	-	-	2
1-Low		**2-Medium**									**3-High**		

Course Title: Renewable Energy Sources			
Course Code: P18EEO752	**Semester: VII**	**L.T.P.H: 3-0-0-3**	**Credits:03**
Contact Period: Lecture: 52Hrs Exam: 3 Hrs		**Weightage: CIE:50% SEE:50%**	

Course Learning Objectives

After going through the course, the students should be able to:

1. Appreciate the importance of various types of energy sources and understand the need for studying renewable energy sources.
2. Understand the various types of conversion methods of solar radiations into heat and know the various types of solar collectors and applications.
3. Know the significance of wind energy and understand the basic principles and its applications.
4. Understand the need for biomass energy and to know the various types of biomass conversion technologies.
5. Understand the relevance of various types of ocean and tidal energy conversion systems and to know the different types of arrangements and application.

Course Content

Unit-I

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India. Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface.

08 Hrs

Self-Study: Solar Thermal Energy Applications.

Unit-II

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond. Solar Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic Panels.

Self-Study: Applications of Solar Cell Systems. **12 Hrs**

Unit-III

Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy.

Wind Energy: Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection. Geothermal Energy: Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems,

environmental Effects. Solid waste and Agricultural Refuse: Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling.

Self-Study: Sources and Types of Waste, Recycling of Plastics. **12 Hrs**

Unit-IV

Biomass Energy: Biomass Production, Energy Plantation,Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers. Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics.

Tidal Energy: Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power.

Self-Study: Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy. **12Hrs**

.Unit-V

Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power. Ocean Thermal Energy: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), OTE plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Advantages, Disadvantages and benefits of OTEC.

Self-Study: Application of OTEC in Addition to Produce Electricity, **8 Hrs**

TextBook

1. Rai, GD,Non-conventional sources of energy,4th Edition ,Khanna publishers,New Delhi,2007.

Reference Books:

1.KhanBH,Non-conventional energy resources, TMH,New Delhi,2006.

2.Mukherjee,D&ChakrabortiS,Fundamentals of Renewable Energy Systems, New Age International Publishers,2005.

Course outcomes

After completion of this course students shall be well versed with the following information:

CO1: Discuss various types of energy sources

CO2: Analyze solar energy applications to thermal and electric system.

CO3: Describe wind energy conversion system for power generation.

CO4: Depict Biomass conversion technology to produce the biogas and bio fuel.

CO5: Analyze various principles to extract energy from ocean.

Course Articulation Matrix														
Course Outcome – CO	**Program Outcome**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
Discuss various types of energy sources	3	2	-	-	-	1	1	-	-	-	1	-	2	-
Analyze solar energy applications to thermal and electric system.	3	3	-	-	-	1	1	-	-	-	1	-	2	-
Describe wind energy conversion system for power generation.	3	2	-	-	-	1	1	-	-	-	1	-	2	-
Depict Biomass conversion technology to produce the biogas and bio fuel.	3	2	-	-	-	1	1	-	-	-	1	-	2	-
Analyze various principles to extract energy from ocean.	3	2	-	-	-	1	1	-	-	-	1	-	2	-
3-High			**2-Medium**								**1-Low**			

Course Title: Hybrid Electric Vehicles			
Course Code: P18EEO753	**Semester: VII**	**L-T-P-H: 3-0-0-3**	**Credits – 03**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50% SEE:50%**	

Course Content

Unit-I

Introduction: Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs.

Hybridization of the Automobile: Vehicle Basics, Basics of the EV, Basics of the HEV, Basics of Plug-In Hybrid Electric Vehicle (PHEV), Basics of Fuel Cell Vehicles (FCVs). HEV Fundamentals: Introduction, Vehicle Model, Vehicle Performance, EV Power train Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle.

Self-Study:-Wheel Slip Dynamics.
12Hrs

Unit-II

Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs.

Self-Study:- Vehicle-to-Grid Technology.

10 Hrs

Unit-III

Power Electronics in HEVs: Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Modelling and Simulation of HEV Power Electronics, Emerging Power Electronics Devices, Thermal Management of HEV Power Electronics.

12Hrs

Self-Study :- Circuit Packaging

Unit-IV

Electric Machines and Drives in HEVs: Introduction, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modeling of Traction Motors. **8Hrs**

Self-Study :- Induction Motor Drives

Unit-V

Batteries, Ultra capacitors, Fuel Cells, and Controls: Introduction, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Modelling Based on Equivalent Electric Circuits, Battery Charging Control, Charge Management of Storage

Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System.
Self-Study:-Hydraulic Energy Storage System**10Hrs**

Text Book:

1.Hybrid Electric Vehicles principles and Applications with Practical Perspectives Chris Mi.MAbulMasrur, Davi D WenzhogGao

Course outcomes

After completion of this course students shall be well versed with the following information:
CO1: Understanding the knowledge of different types of hybrid electric vehicles.
CO2: To get knowledge of Plug-in hybrid electric vehicles.
CO3: To study and analyze the different converters used in HEV's
CO4: Get a basic knowledge of types of motors used in HEV's
CO5: To get knowledge of batteries and batteries management systems.

Course assessment Matrix(CAM)

	Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))											
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	Understanding the knowledge of different types of hybrid electric vehicles.	**L1**	L	M	H	_	M	_	_	_		_	_	_
2	To get knowledge of Plug-in hybrid electric vehicles.	**L2**	M	L	M	_	H		_	_	_	_	_	_
3	To study and analyze the different converters used in HEV's	**L3**	M	H	M	_	L	_	_	_	_	_	_	_
4	Get a basic knowledge of types of motors used in HEV's	**L4**	L	H	M	_	L	_	_	_	-	_	_	H
5	To get knowledge of batteries and batteries management systems.	**L5**	M	H	M		H	-	-	-	-	-	-	M
	L-Low, M-Moderate, H-High													

Course Title: Automation Engineering			
Course Code: P18EEO754	**Semester: VII**	**L-T-P-H: 3-0-0-3**	**Credits – 3**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50% SEE:50%**	

Course Content

Unit 1

Need and benefits of automation, PLC system: applications of PLC, PLC modules, I/O module, Communication module, PID module, Input analog and digital devices, Output analog and digital devices.

Self-Study: List the forms and specifications of PLCs available from various manufacturers**10Hrs**

Unit 2

PLC registers, PLC timer function, PLC counter function, PLC simple arithmetic and logical functions, PLC ladder logic diagram, Advanced PLC functions like SKIP, MASTER CONTROL RELAY, JUMP with non-return, jump with return, Sequencer function

12Hrs

Self-Study: Master control internal relay

Unit 3

PLC applications: Bottling filling plant, Material handling elevator, 2-axis robot with sequencer control, Level control, Trouble shooting

Self-Study: Case study of a real time SCADA Application **10Hrs**

Unit 4

Introduction to DCS, concept of DCS, hierarchy of DCS, function of each level of DCS, Introduction to supervisory Control and Data Acquisition system (SCADA), SCADA Architecture, Interfacing SCADA with PLC

10Hrs

Self-Study: Examples of Commercial Network systems

Unit 5

Induction motor drive: V/F Control, Direct torque control, Stepper motor drives, AC and DC Servo motor drives, DC motor drives

Self-Study: retentive timer, Timer/counter sequencer

10Hrs

Text Books:

1. Webb John W. and Reis A. Ronald, “Programmable Logic Controllers Principles and applications” PHI ,New Delhi, Latest edition

2 Bolton W, “Programmable Logic Controllers” Elsevier India Pvt. Ltd. New Delhi

3 John R Hackworth, “Programmable Logic Controllers” Pearson education New Delhi, Latest edition 4 C. D. Johnson, “Process Control Instrumentation” John Wiley & Sons .

Reference Books:

1 Liptak, “Instrumentation Engineering Handbook” Chilton Book Company, Latest edition

2 Popovic & Bhatkar, “Distributed Computer Control for Industrial Automation” CRC Press, New Delhi, Latest edition

COURSE OUTCOMES:

CO1: To Understanding basics of automation.
CO2: To study about PLC programming and instructions.
CO3: To analyze the applications of PLC
CO4: To get the basic knowledge of DCS & SCADA
CO5: Understand the basic of motor drives.

Course Articulation Matrix (CAM)

Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))											
		a	**B**	**C**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**L**
To Understanding basics of automation.	L1	**L**	**M**	**H**	-	-	**L**	**M**	-	-	-	**M**	-
To study about PLC programming and instructions.	L2	**M**	**M**	**L**	-	-	**M**	-	-	-	-	**H**	-
To analyze the applications of PLC	L3	**L**	**L**	**H**	-	-	**L**	**M**	-	-	-	**M**	-
To get the basic knowledge of DCS & SCADA	L3	**L**	**M**	**M**	-	-	**L**	**M**	-	-	-	**M**	**H**
Understand the basic of motor drives	L4	**M**	**H**	**L**	-	-	-	**L**	-	-	**M**	**H**	**H**
L- Low, M- Moderate, H-High													

Course Title : Relay and High Voltage Laboratory			
Course Code : P18EEL76	**Semester : VII**	**L- T- P-H : 0 - 0 –3-3**	**Credits-1.5**
Contact Period: Lecture: 36 Hrs, Exam: 3 Hrs		**Weightage: CIE:50 SEE:50**	

Course Learning Objectives (CLOs)

This course aims

To conduct practical experiments on Relay and High voltage equipment; IDMT directional/non-directional relay, differential relay, over voltage relay, feeder protection, Spark over characteristics of air (HVAC/HVDC), impulse generator & Partial Discharge analysis for different insulation at different pressure.

List of Experiments

A. RELAY LAB

1. Over current relay**:**
   (a) IDMT non-directional characteristics
   (b) Directional features
   (c) IDMT directional characteristics
2. DMT Characteristics of over voltage or under voltage relay.
3. Generator protection –Merz-Price- protection scheme.
4. Feeder protection scheme-fault studies.
5. Motor protection scheme-fault studies.

B. HIGH VOLTAGE LAB

1. Spark over characteristics of air insulation subjected to HVAC & HVDC for uniform and non- uniform fields
2. Measurement of HVAC and HVDC using standard spheres.
3. To determine 50% probability flashover voltage using impulse generator
4. Partial Discharge characteristics at low pressures using vacuum system and high pressure chamber.
5. Breakdown characteristics of gaseous/liquid insulation using power/high frequency voltage generator.

C. Self-study experiment

Course Outcomes

Student will be able to

1. Conduct experiments to analyze the operation of relays and protection scheme for generator
2. Analyze the characteristics of HVAC, HVDC , impulse generators, and partial discharges by conducting experiments.
3. Ability to communicate effectively in a team/as an individual s to conduct experiments

Course Articulation Matrix															
Course Outcome (CO)	**Program Outcome**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Conduct experiments to analyze the operation of relays and protection scheme for generator	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	2	2
Analyze the characteristics of HVAC, HVDC , impulse generators, and partial discharges by conducting experiments.	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	2	2
Ability to communicate effectively in a team/as an individual s to conduct experiments	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**-**	**-**	**-**	**-**
L- Low				**M- Medium**										**H-High**	

Topic learning objective:

1. IDMT directional &non directional characteristics of over current relay
2. DMT Characteristics of over voltage or under voltage relay
3. Merz-Price- protection scheme
4. Feeder protection for different faults
5. Motor protection scheme-fault studies
6. Spark over characteristics of air in HVAC for uniform &non uniform fields
7. Spark over characteristics of air in HVDC for uniform &non uniform fields
8. Measurement of HVAC
9. Measurement of HVDC
10. 50% probability flashover voltage using impulse generator
11. Partial Discharge characteristics at low & high pressure using vacuum system chamber.
12. Breakdown characteristics of gaseous/liquid insulation using power/high frequency

Course Title : Power System Simulation Lab			
Course Code : P18EEL77	**Semester : VII**	**L-T–P-H: 0-0-3-3**	**Credits : 1.5**
Contact Period: Lecture: 36 Hr, Exam: 3 Hr			**Weightage: CIE:50 SEE:50**

Course Learning Objectives (CLOs)

This course aims

To simulate the experiments to form formation of Y bus by inspection method and singular transformation method, find the bus currents bus voltages, and line flow of the specified system. Find the different faults of a transmission line and study the load flow analysis.

List of Experiments

1. **C**alculation of ABCD parameters for medium and long transmission line systems. Verification of AD-BC=1. Determination of efficiency and regulation.
2. (i)Y-Bus formation for power systems by inspection method.(ii) Determination of bus currents, bus power and line flows for a specified system with given bus voltage profile.
3. Bus admittance matrix (Y – Bus) formation for power systems with and without mutual Coupling, by singular transformation.
4. To determine fault currents and voltages in a single transmission line system with a Specified location for SLG fault, LL fault, and LLG (DLG) fault.
5. Determination of power angle diagram of salient and non-salient pole synchronous machines. Calculation of reluctance power & regulation.
6. To determine I) Swing curve II) Critical clearing time for a single machine connected to Infinite bus through a pair of identical transmission lines.
7. Determination of optimal generator scheduling for thermal plants.
8. Load flow analysis using (i) Gauss Siedel method, (ii) Newton Raphson method, and (iii) Fast decoupled flow method for both PQ and PV buses using software package.
9. Self-Study experiment viz. Analysis of typical power system (problems) by using software package or MATLAB programs.
10. Self-study experiment / simulation

Course Outcomes

Student will be able to

1. Apply the knowledge of power systems for formation of Y bus with and without mutual coupling using MATLAB Programming
2. Conduct experiments to execute programs to study load flow, different faults and stability of the power system.
3. Ability to communicate effectively in a team/as an individuals to conduct experiments

Course Articulation Matrix														
Course Outcome (CO)	**Program Outcome**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Apply the knowledge of power systems for formation of Y bus with and without mutual coupling using MATLAB Programming	**3**	**3**	**-**	**-**	**3**	**-**	**-**	-	-	-	**-**	-	2	-
Conduct experiments to execute programs to study load flow, different faults and stability of the power system.	**3**	**3**	**-**	**-**	**3**	**-**	**-**	-	-	-	**-**	-	-	2
Ability to communicate effectively in a team/as an individual s to conduct experiments	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**-**	-	-	-
L- Low			**M- Medium**											**H-High**

Course Title: Project Work Phase – I and Project Seminar			
Course Code: P18EE78	**Semester: VII**	**L:T:P:H: 0:0:0:4**	**Credits :02**
Weight age: CIE:100			

Project Work: The Project Work (Phase I + Phase II) carries 8 credits (2 credits+6 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.

Course Title: Renewable Energy Sources			
Course Code: P18EE81	**Semester: VIII**	**L-T-P-H: 4-0-0-4**	**Credits –04**
Contact period : Lecture: 52Hrs, Exam 3		**Weightage : CIE:50%SEE:50%**	

Course Learning Objectives

After going through the course, the students should be able to:

1. Appreciate the importance of various types of energy sources and understand the need for studying renewable energy sources.
2. Understand the various types of conversion methods of solar radiations into heat and know the various types of solar collectors and applications.
3. Know the significance of wind energy and understand the basic principles and its applications.
4. Understand the need for biomass energy and to know the various types of biomass conversion technologies.
5. Understand the relevance of various types of ocean and tidal energy conversion systems and to know the different types of arrangements and application.

UNIT-1

Energy Sources: Introduction, Importance of energy consumption as measure of prosperity, per capita energy consumption, Classification of energy resources; Conventional energy resources-availability and their limitations, non-conventional energy resources-Classifications, advantage, limitations; world energy scenario; Indian energy Scenario.

5Hrs

Solar Energy Basics: Introduction, Solar constant, Basic sun-Earth angle-definition & their representation, solar radiation geometry(Numerical Problems).Estimation of solar radiation of horizontal and tilted surface(Numerical Problems).Measurement of Solar Radiation data-Pyranometer & Pyrheliometer.

5Hrs

Self-Study: Comparison of conventional and non-conventional energy resources.

UNIT-2

Solar Thermal System: Solar water heater (Flat plate collectors) solar cookers-box type, concentrating dish type, solardriers, still furnaces, green houses.

Solar Electric System: Solar thermal electric power generation-solar pond & concentrating solar collector (Parabolic trough, parabolic dish central collector), advantages and disadvantages; Solar Photovoltaic-solar cell fundamentals, characteristic, classification, construction of module, panel& array. Solar PV systems-stand-alone/grid connected; applications-street lightning, domestic lightning & solar water pumping systems.

10Hrs

Self-Study: Principle of conversion of solar radiation into heat,

UNIT-3

Wind Energy: Introduction, history of wind energy, scenario – world & India. Basic principle of Wind energy conversion system (WECS), classifications of WECS, part of a WECS. Derivation of power in the wind, electrical power output & capacity factor of WECS, wind site selection consideration, advantages & disadvantages of WECS

10Hrs

Self-Study: Wind& its property

UNIT-4

Biomass Energy: Introduction, Biomass fuel, biomass conversion technologies, urban waste to energy conversion, Biomass gasification, biomass to ethanol production, Biogas production from the waste biomass, factors affecting Biogas generation, types of Biogas plants – KVIC & Janata Model; Biomass programme in India. **10Hrs**

Self-Study: Photosynthesis process

UNIT-5

Energy From Ocean: Components of tidal power plant(TPP), classification of tidal power plant, estimation of energy-single Basin & Double Basin type TTP(no derivation, simple numerical problems), Advantages & Limitation of TTP. Ocean thermal Energy Conversion (OTEC) - principle of OTEC System, method of OTEC power generation-open cycle(Claude Cycle),closed cycle(Anderson cycle) &Hybrid cycle(Block diagram description only). Introduction to Grid integration

12Hrs

Self-Study: Principle of Tidal power, Tidal energy

Text Book:

1. Rai, GD, Non-conventional sources of energy,4th Edition,Khannapublishers,New Delhi,2007.

Reference Books:

1.KhanBH,Non-conventional energy resources, TMH, New Delhi,2006.

2.MukherjeeD&ChakrabortiS,Fundamentals of Renewable Energy Systems, New Age International Publishers,2005.

Course outcomes

After completion of this course students shall be well versed with the following information:

CO1: Discuss various types of energy sources

CO2: Analyze solar energy applications to thermal and electric system.

CO3: Describe wind energy conversion system for power generation.

CO4: Depict Biomass conversion technology to produce the biogas and bio fuel.

CO5: Analyze various principles to extract energy from ocean.

Course Articulation Matrix														
Course Outcome – CO	**Program Outcome**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
Discuss various types of energy sources	3	2	-	-	-	1	1	-	-	-		1	2	-
Analyze solar energy applications to thermal and electric system.	3	3	-	-	-	1	1	-	-	-		1	2	-
Describe wind energy conversion system for power generation.	3	2	-	-	-	1	1	-	-	-		1	2	-
Depict Biomass conversion technology to produce the biogas and bio fuel.	3	2	-	-	-	1	1	-	-	-		1	2	-
Analyze various principles to extract energy from ocean.	3	2	-	-	-	1	1	-	-	-		1	2	-
3-High					**2-Medium**								**1-Low**	

Course Title: HVDC Power Transmission			
Course Code:	**Semester: VIII**	**L-T-P-H: 2-2-0-4**	**Credits –03**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50% SEE:50%**	

Course Learning Objectives

1. Comparison of DC transmission with respect to AC transmission
2. Analysis of converters – assumptions, characteristics & Properties
3. Analysis of Gratez circuit (rectification & inversion)
4. To study the control strategies involved in DC Transmission
5. To know about the role of protection, harmonics & filters in DC transmission

Course content

Unit – I

General Aspects of DC Transmission and Comparison of it with AC Transmission: Historical sketch, Types of DC links, Comparison of AC and DC transmission, Description of DC transmission systems, Principal applications of DC transmission, Modern Trends in HVDC Technology, Planning for HVDC Transmission. **10Hrs**

Self-study : HVDC transmission based on VSC

Unit –II

Converter circuits: Valve characteristics, Properties of converter circuits, Assumptions, Single phase converters, Pulse number, Three phase converters; one way and two way (6 pulse)converters, Twelve pulse cascade of two bridges (Characteristics and analysis are excluded), Choice of best circuit for HVDC converter

10Hrs

Self-study : Additional six pulse converter circuits

Unit -III

Analysis of Three phase bridge converter: Analysis with grid control without overlap; current and phase relations, Analysis with grid control and overlap less than 60˚; voltage reduction due to commutation overlap, Mode 1, Mode 2 and Mode 3 operation, Vd-Id Characteristics of Converter, Inversion.

10Hrs

Self-study : Series and parallel arrangements of valves, anodes or bridges

Unit –IV

Control strategies: Basic means of control, Power reversal, Limitations of manual control, Constant voltage versus constant current control, desired features of control, Actual control characteristics, Constant minimum ignition angle control, Constant current control, Stability of control, Power control and current limits, MTDC systems (configurations only)**12Hrs**

Self-study : Constant extinction angle control, Tap changer control, power control and current limits

Unit –V

Protection: General, Prevention of consequent commutation failures, Converter faults, DC Circuit breakers, Clearing line faults and re-energizing the line.

Harmonics and Filter: Characteristic and Uncharacteristic harmonics, Telephone interference, Troubles caused by harmonics, Means of reducing harmonics, Harmonic filters.
10Hrs

Self-study : DC reactors

Text Book:

1. Direct Current Transmission, E. W. Kimbark, - Volume I, Wiley futerscience, 1971

2. Power System Stability and Control, Prabha Kundur , Tata McGraw Hill, 9th Reprint, 2007.

Reference Books:

1. HVDC Power transmission systems - Technology and System Interactions, K. R. Padiyar, Eastern Limited, 1992.

2. High voltage direct current transmission, J. Arrillaga, 2nd edition, 2007

Course Outcomes:

CO1: Apply the knowledge of transmission and distribution system to study AC transmission & DC transmission.

CO2: Analyze various converter circuits used in HVDC transmission.

CO3: Apply the concept of power electronics to study three phase Bridge Converter.

CO4: Examine different HVDC transmission control strategies.

CO5: Analyze the concept of Protection in HVDC transmission.

Course Articulation Matrix														
Course Outcome (CO)	**Program Outcome**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Apply the knowledge of transmission and distribution system to study AC transmission & DC transmission.	3	2	-	-	-	-	-	-	-	-	-	-	2	2
Analyze various converter circuits used in HVDC transmission.	2	3	-	-	-	-	-	-	-	-	-	-		2
Apply the concept of power electronics to study three phase Bridge Converter.	3	3	-	-	-	-	-	-	-	-	-	-	2	2
Examine different HVDC transmission control strategies.	2	2	-	-	-	-	-	-	-	-	-	-		2
Analyze the concept of Protection in HVDC transmission.	2	3	-	-	-	-	-	-	-	-	-	-		2
3-High			2-Medium										1-Low	

Course Title: Energy Auditing & Demand Side Management			
Course Code: P18EE822	**Semester: VIII**	**L-T-P-H: 2-2-0-4**	**Credits –03**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50% SEE:50%**	

Course Learning Objectives

The course will enable the students to understand:

1. Energy situation in the world and in India, Time value of money concept, Developing cash flow models, Payback analysis, taxes and tax credits, concept of ABT.
2. Energy audit, presentation of energy audit results, measurements in energy audit.
3. Power factor correction, energy efficient motors and lighting basics.
4. Concept of DSM, benefits of DSM, Different techniques of DSM. awareness program for Energy conservation and load management

Course Content

Unit1

Introduction: Energy Sources-Primary & Secondary sources, Commercial & noncommercial sources, Renewable & nonrenewable sources. Energy situation in the world and India, Energy consumption, Energy Conservation- Three Pronged Approach to Energy Management: Capacity utilization, Technology up gradation, fine tuning of the equipment. The power flow concept. Electrical distribution Codes, standards for electrical equipment, regulations, other legal Provisions and Legislation.

Energy Economic Analysis: The time value of money concept, Interest, Types of interest-simple interest, compound interest, nominal interest, effective interest, present worth, future worth. Developing cash flow models, payback analysis, advantages and disadvantages of payback analysis, depreciation, methods of depreciation, Concept of ABT, broad features of ABT design and numerical problem. **12Hrs**

Self-Study: Taxes and tax-credit

Unit2

Energy Auditing: Introduction, Definition & objectives of Energy Management, Principles of management, Energy management strategy, Elements of energy audits, energy audit: types and methodology, preliminary audit and detailed audit, role of energy management team, energy audit reporting format, energy use profiles, Audits required to construct the energy use profiles: envelop audit, functional audit, process audit, transportation audit, utility audit, measurements in energy audits, presentation of energy audit results, energy audit instruments: combustion analyzer, fuel efficiency monitor, fyrite, contact thermometer, infrared thermometer, pitot tube and manometer, water flow meter, speed measurements, leak detectors, lux meters. **12Hrs**

Self-Study: Electrical System Optimization

Unit3

Electrical Equipment and power factor correction: Power factor improvement-Power factor, causes of low power factor, advantages of high power factor, disadvantages of low power factor, Power factor improvement equipment-static capacitors, synchronous condenser, and phase advancers. Calculation of power factor correction, importance of power

factor improvement, most economical power factor, location & sizing of capacitors, energy efficient motors, Numerical on power factor correction. **10Hrs**

Self-Study: Lighting basics

Unit4

Demand Side Management: Introduction to DSM, concept of DSM, benefits of DSM,

DSM planning and implementation, different techniques of DSM–time of day pricing and metering, multiutility power exchange model, load management, Load priority technique-direct load control technique, local load control technique, distributed load control technique. **08HrsSe**

lf-Study: Energy efficient technology in electrical system.

Unit5

Load management: Peak clipping, load shifting, valley filling, strategic energy conservation, strategic load growth, flexible load shape, energy efficiency improvement, Different time zones, Tariff option for DSM- time of day tariff, seasonal tariff, curtailable tariff, End use energy conservation, customer acceptance of DSM, DSM implementation issues, DSM implementation strategies, Management and Organization of Energy Conservation awareness Programs- Plant level, Division level, corporate level.

10Hrs

Self-Study: Energy efficient lighting controls and Integrated energy policy.

Text Books:-

1**.** "Fundamentals of Energy Engineering" - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey.

2. Electrical distribution – Pabla, TMH Publishers, 2004.

Reference Books:-

1. "Demand Side Management"-Jyothi Prakash, , TMH Publishers, 2000.
2. Hand book on energy auditing - TERI (Tata Energy Research)
3. Principles of Power system V.K. Mehtha, , S.Chand& Company Ltd. 2002
4. Hand book of Electrical power Distribution, Gorti Ramamurthy, University press, 2nd edition, 2009

Course Outcomes

CO1: Explain Energy situation in India and World, Concept of Time value of money concept and ABT.

CO2: Conduct energy audits and determine energy use profiles by applying knowledge of power generation.

CO3: Analyze location & sizing of capacitors and energy efficient motors.

CO4: Illustrate the concept Demand Side Management along with its benefits. Also different techniques of DSM.

CO5: Explain Load Management, DSM implementation issues and Strategies

Course Articulation Matrix														
Course Outcome (CO)	**Program Outcome**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Analyze the energy situation in India and around the world	3	3	-	-	-	1	-	-	-	-	-	1		2
Conduct energy audits and determine energy use profiles by applying knowledge of power generation.	3	2	-	-	-	1	-	2	2	2	2	1	-	2
Analyze the sizing and location of capacitors with low electrical consumption.	2	3	-	-	-	-	-	-	-	-	-	-	-	2
Illustrate the concept of Demand Side Management.	2	2	-	-	-	1	-	-	-	-	-	1	-	2
Explain Load Management, DSM implementation issues and Strategies.	2	2		-	-	2	2	-	-	-	-	-		2
3-High	2-Medium											1-Low		

Course Title: Power System Operation And Control			
Course Code: P18EE823	**Semester: VIII**	**L-T-P-H: 2-2-0-4**	**Credits:03**
Contact Period: Lecture: 52Hrs Exam 3 Hrs	**Weightage: CIE:50% SEE:50%**		

Course Learning Objectives (CLOs)

This course aims is to:

1. To get the overview of computer control centers for power systems.
2. To understand the methods of controlling power generation
3. To study the methods of controlling load-frequency
4. To study the need of Unit commitment
5. To understand about power system security

Course Content

Unit – I

Control center operation of power systems: Introduction to Computer Control center, digital computer configuration, Automatic generation control, Area control error, Operation without central computers, Expression for tie-line flow and frequency deviation, Parallel operation of generators, problems on tie-line frequency.

10Hrs

Self-study: Area lumped dynamic model

Unit – II

Automatic Generation Control: Automatic control loops of generators: AGC and AVR. Automatic Load Frequency Control (ALFC/LFC) of single area systems-turbine speed governing system, turbine model, generator- load model, steady state analysis, dynamic response, concept of control area, load frequency control of -two area systems, Automatic voltage regulator **10Hrs**

Self-study: state space model of two area load frequency control

Unit – III

Control of voltage and Reactive Power: Introduction, sending and receiving end voltages in terms of power and reactive power, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, methods of voltage control-Injection of Reactive Power: shunt capacitors and reactors, series capacitor, synchronous compensator, static VAR compensator and STATCOMs, Tap-Changing Transformers, Voltage stability and Voltage collapse.

Self-study: Voltage control in Distribution Network **12 Hrs**

Unit –IV

Unit Commitment: Statement of the problem, need and importance of unit commitment, constraints in unit commitment: spinning reserve, Thermal unit constraints, other constraints problems on priority list method, Methods of Unit commitment -priority lists method.

10Hrs

Self-study: Dynamic programming solution

Unit –V

Power System Security: Introduction, factors affecting power system security, Power system contingency analysis, Detection of network problems, network sensitivity methods, calculation of network sensitivity factor, contingency ranking. **10Hrs**

Self-study: Concentric relaxation

Text Books:

1. "Power generation, operation and control", by: Allen J.Wood& B F Woollenberg. John Wiley and
Sons,Publications II-Edition 2010.
2 "Computer Aided Power System Analysis", by: G.L. Kusic, PHI,2010
3. "Electric Power Systems", by: B. M. Weedy, B.J. Cory, Wiley, 5th Edition, 2010.

Reference Books:

1."Modern Power System Analysis", by D.P. Kothari and I.J. Nagrath, ThirdEdition,Tata-McGrawHillPublishingCompanyLimited,NewDelhi,2010.

Course Outcomes

After learning all the units of the course, the student is able to:

CO1: Apply the knowledge of power system to study the control center operation of Power System.

CO2: Analyze the different methods of automatic generation control.

CO3: Examine the various methods of controlling voltage and reactive power.

CO4: Illustrate the different methods to find solution of Unit commitment.

CO5: Analyze different power system security issues in order to solve network problems

Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of power system to study the control center operation of Power System.	3	2											2	
2	Analyze the different methods of automatic generation control	2	3												2
3	Examine the various methods of controlling voltage and reactive power.	2	3												2
4	Illustrate the different methods to find solution of Unit commitment.	2	3												2
5	Analyze different power system security issues in order to solve network problems	2	3												2
3-High				2-Medium										1-Low	

Course Title: Smart Grid			
Course Code: P18EE824	**Semester: VIII**	**L-T-P-H: 2-2-0-4**	**Credits –03**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50%; SEE:50%**	

Course Content

Unit-I

Smart Grid Architectural Designs: Introduction, Today's Grid versus the Smart Grid, Energy Independence and Security Act of 2007: Rationale for the Smart Grid, Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Working Definition of the Smart Grid Based on Performance Measures, Representative Architecture, Functions of Smart Grid Components. Smart Grid Communications and Measurement Technology: Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multi agent Systems (MAS) Technology.

Performance Analysis Tools for Smart Grid Design: Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, DSOPF Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingencies and Their Classification. **12Hrs**

Self-study: Microgrid and Smart Grid Comparison, Contingency Studies for the Smart Grid.

Unit-II

Stability Analysis Tools for Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability. **8 Hrs**

Self-study: Assessment, State Estimation.

Unit-III

Computational Tools for Smart Grid Design: Introduction to Computational Tools, Decision Support Tools, Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges. Pathway for Designing Smart Grid: Introduction to Smart Grid Pathway Design, Barriers and Solutions to Smart Grid Development, Solution

Pathways for Designing Smart Grid Using Advanced Optimization and Control Techniques for Selection Functions, General Level Automation, Bulk Power Systems Automation of the Smart Grid at Transmission Level, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid. **12Hrs**

Self-study: Applications for Adaptive Control and Optimization

Unit-IV

Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Penetration and Variability Issues Associated with Sustainable Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits. Interoperability, Standards, and Cyber Security: Introduction, Interoperability, Standards, Smart Grid Cyber Security.

Self-study: Cyber Security and Possible Operation for Improving Methodology for Other Users.

10 Hrs

Unit-V

Research, Education, and Training for the Smart Grid: Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development. **Case Studies and Test beds for the Smart Grid**: Introduction, Demonstration Projects, Advanced Metering, Microgrid with Renewable Energy, Power System Unit Commitment (UC) Problem, ADP for Optimal Network Reconfiguration in Distribution Automation, Case Study of RER Integration, Test beds and Benchmark Systems.

Self-study: Challenges of Smart Transmission, Benefits of Smart Transmission.**10Hrs**

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

Course Outcomes

After learning all the units of the course, the student is able to:

CO1: Analyze the performance of different smart grid architecture.

CO2: Analyze the stability of the mart grid system.

CO3: Analyze the different computational tools used for smart grid.

CO4: Understand the renewable energy usage and storage.

CO5: Analyze the research area and different trainings or smart grid

Course Title: Internship		
Course Code: P18EE83	**Semester: VIII**	**Credits :02**
Exam Hours :03 Hr	**Weight age: CIE:50; SEE:50**	

Guidelines for Internship:

I. Internship is of minimum eight weeks duration and to be completed between the vacation period of VI & VII semester and VII & VIII semester.

II. The internship can be carried out in any industry/ R & D Organization/ Research/ Institute/ Educational institute of repute/ Internshala (ACITE MoU Internship).

III. The Department/college shall nominate staff member/s to facilitate, guide and supervise students under internship.

IV. The Internal Guide has to visit place of internship at least once during the student's internship.

V. The students shall report the progress of the internship to the guide in regular intervals and seek his/her advice.

VI. After the completion of Internship, students shall submit a report with completion and attendance certificates to the Head of the Department with the approval of both internal and external guides.

VII. There will be 50 marks CIE (Seminar: 25, Internship report: 25) and 50 marks for Viva Voce conducted during Semester End Examination (SEE) of VIII Semester. For the conduction of Internship Semester End Examination following instructions are issued:

a. The Semester End Examination (SEE) for 50 marks shall be conducted similar to final semester project work / lab examination.

b. Internal & External Examiners shall be appointed by the BoE – Chairperson in consultation with HoD and approval of the same by the Principal & Controller of Examination.

c. External Examiner may be from the Industry. If the external examiner from the industry is not available, alternative arrangement shall be made by the BoE - Chairperson by appointing a faculty from out of the available faculty in the department, wherein the student is studying.

VIII. The students are permitted to carry out the internship anywhere in India or abroad. The Institution will not provide any kind of financial assistance to any student for carrying out the Internship.

IX. Failing to undergo Internship: Internship is one of the head for obtaining degree, therefore completion of internship is mandatory.

Course Title: Project Work Phase – II		
Course Code: P18EE84	**Semester: VIII**	**Credits :06**
Weight age: CIE:100 SEE:100		

Project Work: The Project Work (Phase I + Phase II) carries 8 credits (2 credits+6 credits) and spreads over TWO semesters, i.e. during 7th and 8th semesters.

I. Project Phase – I and Project seminar Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and seminar presentation skill.

II. The Assessment marks (CIE) in the case of Project Work - Phase I, shall be based on the evaluation at the end of the 7th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department, one of them may be the internal guide. The work may be evaluated by the committee for award of Assessment marks (CIE) based on a Report [comprising of synopsis, Introduction, Literature survey, Objective and Methodology], presentation and viva voce.

III. The project work shall be carried out by candidate(s) independently/in a group (maximum of four) during the seventh and eighth semester under the guidance of one of the faculty members of the Department of study. If the project work is of inter-disciplinary nature, a co-guide shall be taken from the same or any other relevant Department. If a project work has to be carried out in any industry / factory / organization, outside the campus, the permission for the same and the name of co-guide at any of these organizations shall be intimated to the authorities at the beginning of seventh semester by the Head of the Department.

IV. The weekly progress of the Project work shall be monitored and reviewed by the Project Guide assigned by DUGC. The method of evaluation, including intermediate assessment shall be evolved by the pertinent DUGC.

V. A candidate shall submit N+3 (No. of candidates+3) copies of the Report of the Project Work to Head, DUGC on or before the specified date. The report shall be in the format prescribed by the Institute. The candidate shall submit a report of the project work (dissertation) duly approved by the guide and co-guide. The project report shall be countersigned by the guide, co-guide (if any) and the Head of the Department

VI. The last date for the submission of Report shall be Two weeks before the closure of the semester in which the project work credits have been registered for and is expected to be completed or as announced by the COE. The date of submission of the dissertation may be extended up to a maximum of eight academic years, from the date of commencement of the first semester in which the candidate has taken admission to the course.

VII. The final evaluation (CIE & SEE) for Project Work - Phase II is done by a Project Work Evaluation Committee (PWEC) constituted by the pertinent DUGC. There shall be an open seminar followed by a viva – voce examination as part of the final evaluation. After the final evaluation, appropriate letter grade is awarded.

VIII. If in the opinion of the PWEC, the Project Report is acceptable with minor modifications for the minimum passing grade 'E'(Fair) in the case of project, the PWEC shall value and instruct the candidate suitably to incorporate the

necessary modifications and to resubmit it to the Chairman, PWEC. After such resubmission, the Chairman, PWEC will certify that the necessary modification has been incorporated.

IX. The Assessment marks in case of Project Work - Phase II and seminar shall be based on the evaluation, as per the guidelines, at the end of the 8th semester by a committee consisting of Head of the concerned department, two senior faculty members of the department (one of them may be the internal guide).

X. The Assessment marks sheet shall bear the signature of all those concerned, along with the date and seal of the Principal.

Course Title: Self-Study Course & Seminar			
Course Code: P18EE85	**Semester: VIII**	**L:T:P:H: 0:0:4:4**	**Credits :02**
Weight age: CIE: 50			

In the Self-Study course & Seminar, the student has to choose & study the courses related to the program discipline with her/his own efforts under the guidance of a Course Instructor/Project guide, using study materials available in open sources i.e. Massive Open Online Course (MOOC) NPTEL Courses. The intention of the course is to encourage the habit of self-learning.

Further, in addition to the above, the department has to release the pool of courses from the list of available 8 weeks NPTEL online courses. The student has to register for the course from the available pool during VII / VIII Semester and the same will be reflected in the Grade Card of the VIII Semester. The 50 marks CIE assessment is based on the final NPTEL score (i.e. Online assignments: 25% + Proctored exam: 75%). The NPTEL score will be mapped directly to the CIE marks as per the calculation below only if he /she has completed the NPTEL course (i.e. Certification).

CIE = (NPTEL Score X 1.5) / 2 = [Maximum CIE should be 50 Marks]

[Ex. – 1: If NPTEL Score is 60 then the CIE will be = (60 X 1.5)/2 = 45

Ex. – 2: If NPTEL Score is 80 then the CIE will be = (80 X 1.5)/2 = 50 (Max. CIE should be 50 Marks)]

If the student fails to complete the NPTEL course at the end of the VIII Semester, then the department has to constitute a committee consisting of the Head of the department, two senior faculty members of the department, one of them may be the internal guide. The evaluation is based on a Report, Presentation, and Viva-Voce and the assessment is a relative evaluation in context to the student completed NPTEL course Certification (i.e. the CIE Score should be less than the score of the student cleared NPTEL Course).