SYLLABUS

(With effect from 2013-2014)
Out Come Based Education

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2013–14)
ಫಲಿತಾಂಶ ಆಧಾರಿತ ಶಿಕ್ಷಣ

VII and VIII Semester

Bachelor Degree
in

Electrical and Electronics Engineering

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.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ
ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ
(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

Ph : 08232- 220043, Fax : 08232 – 222075,Web : www.pescemandya.org

Department of Electrical & Electronics Engineering

- **Vision :**

  Nurturing excellence in Electrical & Electronics Engineering by imparting professional education with values through innovative learning solutions to develop competent engineers.

- **Mission:**

- Enhance the competence of faculty and staff through FDP.
- Provide students with strong theoretical foundation, research and innovation skills.
- Develop interpersonal communication, team work and ethics.
- Promote entrepreneurial qualities among students.

A. **Program Educational Objectives (PEO)**

PEO1: Excel in professional career and/or higher education by acquiring knowledge in mathematical, computing and engineering principles
PEO 1.1.Progressing professional career
PEO 1.2.Higher education
PEO2: Analyze real life problems, design computing systems appropriate to its solutions that are technically sound, economically feasible and socially acceptable
PEO 2.1.Analyzereal life problem
PEO 2.2.Design and develop economically feasible and socially acceptable Computing Solutions
PEO3: Exhibit professionalism, ethical attitude, communications kills, team work in their profession and adapt to current trends by engaging in lifelong learning.
PEO 3.1.Professional conduct and interpersonal skills
PEO 3.2.Adapting to current trends in technology

B. Programme Outcomes (PO)

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 problems.
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 have the ability for self- education and lifelong learning.
PO-12: Graduates will plan, execute and complete projects

VII Semester B.E. Scheme Of Teaching And Examination 2015- 16

Sl No	Course Code	Course Title	Teaching Dept.	Hours/week Pattern L : T : P	Total Credits	Total Hours/ Week	Examination Marks			Exam Duration in Hours
							CIE	SEE	Total	
1	P13EE71	Computer Techniques in Power Systems	E&EE	4:0:0:0	4	4	50	50	100	3
2	P13EE72	High Voltage Engineering	E&EE	4:0:0:0	4	4	50	50	100	3
3	P13EE73	AC & DC Drives	E&EE	4:0:0:0	4	4	50	50	100	3
4	P13EEL74	Computer Aided Electrical Drawing	E&EE	1.5:0:1.5	3	4	50	50	100	3
5	P13EE75X	Elective-B	E&EE	4:0:0:0	4	4	50	50	100	3
6	P13EE76X	Elective-C	E&EE	4:0:0:0	4	4	50	50	100	3
7	P13EEL77	Power System Simulation Lab	E&EE	0:1:2:3	1.5	3	50	50	100	3
8	P13EEL78	Relay & High Voltage Lab	E&EE	0:1:2:3	1.5	3	50	50	100	3
Total					26	30	400	400	800	

Elective –B

Sl. No.	Course Code	Course
1	P13EE751	Utilization of Electrical Power
2	P13EE752	Fuzzy Logic Control
3	P13EE753	Electrical Distribution Systems
4	P13EE754	Embedded Systems

Elective-C

Sl. No.	Course Code	Course
1	P13EE761	Design of Analog Control Systems
2	P13EE762	Testing and commissioning of Electrical Equipments.
3	P13EE763	Soft Computing Techniques
4	P13EE764	Data Base Management Systems

VIII Semester B.E. Scheme Of Teaching And Examination 2015- 16

Sl No	Course Code	Course Title	Teaching Dept.	Hours /week Pattern L :T :P	Total Credits	Total Hours/ Week	Examination Marks			Exam Duration in Hrs
							CIE	SEE	Total	
1	P13EE81	Energy Auditing & Demand Side Management	E&EE	2:1:0:3	3	4	50	50	100	3
2	P13EE82	Power System Operation & Control	E&EE	2:1:0:3	3	4	50	50	100	3
3	P13EE83X	Elective-D	E&EE	2:1:0:3	3	4	50	50	100	3
4	P13EE84X	Elective-E	E&EE	2:1:0:3	3	4	50	50	100	3
5	P13EE8S5	Seminar	E&EE	2:0:0:2	2	3	50	-	50	-
6	P13EE8P6	Project	E&EE	-	10	15	100	100	200	3
				Total	**24**	**34**	**350**	**300**	**650**	

Elective – D

Sl. No.	Course Code	Course
1	P13EE831	Modern Power System Protection
2	P13EE832	Advanced Electrical Machines
3	P13EE833	Flexible AC Transmission Systems
4	P13EE834	Discrete Time Control Systems

Elective-E

Sl. No.	Course Code	Course
1	P13EE841	Computer Control of Electric Drives
2	P13EE842	Insulation Engineering
3	P13EE843	HVDC Power Transmission
4	P13EE844	Renewable Energy Sources

Evaluation Scheme

Scheme	Weightage	Marks	Event Break Up				
CIE	50%	50	Test I	Test II	Quiz I	Quiz II	Assignment
			35	35	5	5	10
SEE	50%	100	Questions to Set: 10	Questions to Answer: 5			

Semester VII

Course Title: Computer Techniques In Power Systems			
Course Code: P13EE71	**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 (L3).
2. Develop general power flow equations (PFE) or Load flow analysis (LF) equations for an n-bus power system (L4).
3. Solve PFE (LFA) using algorithms such as Gauss-Seidel and Newton-Raphson methods (L4).
4. Analyze or Design a power system for a given operation conditions (L5).
5. To allocate the total demand of a power system by optimizing the overall operating costs (L4).
6. Determine the transient stability of a power system (L5).

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 Hours**

Unit-II.

Network Matrices: Introduction, Formation of YBUS – by method of inspection, by method of singular transformation (YBUS = At[y]A); Formation of Bus Impedance Matrix (without mutual coupling elements). **10 Hours**

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), Comparison of Load Flow Methods. **10 Hours**

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. **10 Hours**

Unit-V.

Transient Stability Studies: Numerical solution of Swing Equation – Point-by-point method, Modified Euler's method, Runge -Kutta method, Representation of power system for transient stability studies **10 Hours**

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:

1. 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: Form the bus admittance matrix for the given power system network by singular transformation method

CO2: Develop general power flow equations (PFE) for an n-bus power system.

CO3: Determining the solution of PFE using algorithms such as Gauss-Seidel and Newton-Raphson methods.

CO4: Design a power system by optimizing the overall operating cost subject to pre-specified constraints.

CO5: Determine the transient stability of a power system

MODEL QUESTION PAPER

<table>
<tr><th>SI.No.</th><th>Model Question Paper</th><th>Marks</th><th>CO's</th><th>Levels</th></tr>
<tr><td colspan="5">PART- A</td></tr>
<tr><td>1.a)</td><td>With a neat sketch define (i) Tree and cotree (ii) Branch and link (iii)Basic loops and Basic cut sets.</td><td>08</td><td>CO1</td><td>L1</td></tr>
<tr><td>b)</td><td>Explain the significance of primitive network and hence get the performance equations in both impedance and admittance form.</td><td>06</td><td>CO1</td><td>L2</td></tr>
<tr><td>c)</td><td>The bus incidence matrix A, of 8-elements, 5-node system is given below. Obtain the element node incidence matrix and the oriented graph. The columns represent elements and the rows represent buses.
<table>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>-1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>-1</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>-1</td><td>0</td></tr>
</table></td><td>06</td><td>CO1</td><td>L4</td></tr>
<tr><td>2.a)</td><td>Derive an expression for obtaining the bus admittance matrix using singular transformations.</td><td>07</td><td>CO1</td><td>L4</td></tr>
<tr><td>b)</td><td>Determine the bus admittance matrix using the singular transformations for thesample power system with the line data shown in table below.
<table>
<tr><td>Line No.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Bus-code (p-q)</td><td>0 - 1</td><td>1 - 2</td><td>2 -3</td><td>3 - 0</td><td>2 – 0</td></tr>
<tr><td>Impedance p.u</td><td>0.8</td><td>0.5</td><td>0.4</td><td>0.5</td><td>0.25</td></tr>
</table></td><td>07</td><td>CO1</td><td>L3</td></tr>
<tr><td>c)</td><td>Explain the steps to modify the Z_{BUS} for removal of a line or modification of the line impedance.</td><td>06</td><td>CO1</td><td>L4</td></tr>
<tr><td>3.a)</td><td>What are different types of buses considered during power system load flow analysis? Explain briefly.</td><td>05</td><td>CO2</td><td>L2</td></tr>
<tr><td>b)</td><td>Determine the voltages at the end of first iteration using Gauss-Seidal method for the system data given below. Assume an acceleration factor of 1.6.
i) Line Data
<table>
<tr><td>Bus Code</td><td>1 - 2</td><td>1 - 3</td><td>2 - 3</td><td>2 - 4</td><td>3 - 4</td></tr>
<tr><td>Admittance</td><td>2 – j 8</td><td>1 – j 4</td><td>0.66–j0.664</td><td>1 – j 4</td><td>2 – j 8</td></tr>
</table>
ii) Bus Data
<table>
<tr><td>Bus No.</td><td>P</td><td>Q</td><td>V</td><td>Remarks</td></tr>
<tr><td>1</td><td>-</td><td>-</td><td>1.06∠0</td><td>SLACK</td></tr>
<tr><td>2</td><td>0.5</td><td>0.2</td><td>1+ j 0</td><td>PQ</td></tr>
<tr><td>3</td><td>0.4</td><td>0.3</td><td>1+ j 0</td><td>PQ</td></tr>
<tr><td>4</td><td>0.3</td><td>0.1</td><td>1+ j 0</td><td>PQ</td></tr>
</table></td><td>15</td><td>CO2</td><td>L3</td></tr>
<tr><td>4.a)</td><td>How tap changing transformers are represented in load flow studies for formation of Y_{bus}matrix.</td><td>04</td><td>CO2</td><td>L1</td></tr>
<tr><td>b)</td><td>Derive the expression in polar form for the typical diagonal elements of the sub matrices of the Jacobian in the Newton Raphson method of load flow analysis.</td><td>10</td><td>CO2</td><td>L2</td></tr>
<tr><td>c)</td><td>Compare NR and GS method LFS procedure in respect of the followings:(i)Time per iteration (ii) Total solution time
(iii) Acceleration of convergence of iterative solution.</td><td>06</td><td>CO2</td><td>L4</td></tr>
<tr><td colspan="5">Part -B</td></tr>
<tr><td>5.a)</td><td>Explain and derive the condition for Economic operation generators with transmission loss considered.</td><td>08</td><td>CO3</td><td>L2</td></tr>
<tr><td>b)</td><td>The fuel costs per hour for plants 1 and 2 are given by:
F1 = 0.2 P12+40 P1 + 120 Rs./Hr.</td><td>08</td><td>CO3</td><td>L4</td></tr>
</table>

	F2 = 0.25 P22+ 30P2 + 150 Rs./Hr. Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100 MW and 25 MW, the demand is 180 MW and the transmission losses are neglected. If the load is equally shared by both the units, determine the saving obtained by loading the units as per equal incremental production cost.			
c)	What are constraints to be satisfied for economic operation of thermal plants?	04	CO3	L1
6.a)	What are transmission line coefficients? Obtain the general loss coefficient formula with usual notations.	10	CO3	L3
b)	A two bus system is shown in the fig.6 (b). If the load of load of the125 MW is transmitted from plant 1 to the load, a loss of 15.65MW is incurred. Determine the generation schedule and the load demand if the cost of received power is Rs. 24/MW-hr. Solve the problem using co-ordination equations and penalty factor method approach. The incremental production costs of the plants are: (dF1/dP1) = 0.025P1 +15 (dF2/dP2) = 0.05P2 +20.	10	CO3	L4
7.a)	With the help of a block diagram explain simplified representation of a speed governor.	08	CO4	L2
b)	With the help of a flow chart and equation explain the transient stability analysis using modified Euler's method	12	CO4	L2
8.a)	Write brief notes any four of the following: a. Rule of Inspection for Y_{bus} formation b. Penalty factors and its impact on economic operation c. Runge- Kutta method for transient stability analysis d. Representation of synchronous machines from transient stability analysis e. Fast decoupled load flow analysis.	20	CO4	L3

Course Title: High Voltage Engineering			
Course Code: P13EE72	**Semester: VII**	**L-T-P-H: 4-0-0-4**	**Credits - 4**
Contact period : Lecture: 50 Hrs, 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 (L2)
2. Students will learn basic need to generate high voltages such as HVAC, HVDC, Impulse Voltages and Impulse Currents in the laboratory. (L3)
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 (L3)
4. Students will learn how to measure the high voltages in the laboratory (L4)
5. Students will know importance of testing and learn procedure of testing different insulating media for accessing their condition (L2)

Relevance of the Course:

The students will examine the basic information and techniques underlying with High Voltage Engineering. The course deeply provides the analysis of Breakdown phenomenon in gaseous, solids and liquid Dielectrics, Criteria for gaseous insulation breakdown - Townsend's theory & Streamer's theory. The course provides the basic need to generate high voltages such as HVAC, HVDC, Impulse Voltages and Impulse Currents in the laboratory. Students gain the fundamental knowledge of physical phenomena of breakdown, partial discharge in insulating media and students will know the importance of insulating media and their applications in various fields.

Course Content

Unit 1.

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, Breakdown in electro-negative gases, 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). **10Hrs**

Unit 2.

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 - Voltage doubler circuit, Cockcroft- Walton type high voltage DC set. Regulation, Ripple and Optimum number of stages. **10Hrs**

Unit 3.

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 three electrode gap arrangement and Trigatron gap, Generation of switching impulse voltage, Generation of high impulse current. **10Hrs**

Unit 4

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; Surge current measurement - Klydanograph and Magnetic link. **10Hrs**

Unit 5

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, Cables, Insulators and Transformers. **10Hrs**

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: Analyse Breakdown phenomenon in gaseous, solids and liquid Dielectrics

CO2: Understand generation of HVAC and HVDC in High Voltage Laboratory

CO3: Understand generation of Impulse Voltage and Current in High Voltage Laboratory

CO4: Understand and Analyse measurement principles for HVAC, HVDC and Impulse Voltages

CO5: Understand Non-Destructive and Destructive Techniques of various High Voltage Insulation and Electrical apparatus

Model Question Paper

	PART - A	marks	CO's	Level
1 a.	Discuss the need for generation of high voltages in laboratory.	5	CO1	L1
b.	Derive an expression for growth of current in gaseous medium under uniform field condition assuming both Townsend's first and second ionization process to be in progress.	10	CO1	L3
c.	Discuss breakdown phenomena in electro negative gases.	5	CO1	L4
	or			
2 a.	Explain Suspended particle theory of breakdown in liquid dielectrics.	8	CO1	L2
b.	What is Paschen's law? Discuss the breakdown effect of breakdown voltage over a wide range for the product of pressure and gap spacing.	8	CO1	L1
c.	Explain thermal breakdown phenomenon in solid dielectrics.	6	CO1	L2
3 a.	What is Paschen's law? Discuss the effect of breakdown voltage over a wide range for the product of pressure and gap spacing.	10	CO2	L3
b.	Explain suspended particle theory of breakdown in liquid dielectrics.	5	CO2	L2
c.	Explain thermal breakdown phenomena in solid dielectrics.	5	CO2	L1
	or			
4 a.	Explain how HVDC is generated using Cockroft – Walton voltage multiplier circuit.	8	CO2	L2
b.	Derive an expression for ripple voltage and regulation using Cockroft – Walton Voltage multiplier circuit.	8	CO2	L3
c.	Explain how HVAC is generated using cascaded transformer.	6	CO2	L2
5 a.	Explain how HVAC can be generated using Tesla coil.	5	CO3	L2
b.	Explain with neat sketch three stage cascade connection of transformer for producing HVAC.	10	CO3	L2
c.	A 100 kVA, 400 V/250 kV testing transformer has 8% leakage reactance and 2% resistance on 100 kVA base. A cable has to be tested at 500 kV using the above transformer as a resonant transformer at 50 Hz. If the charging current of the cable at 500 kV is 0.4 A, find the series inductance required.	5	CO3	L4
	or			
6 a.	An impulse current generator has a total capacitance of 8 uF. The charging voltage is 25 kV. If the generator has to give an output current of 10kA with 8/20us waveform. Calculate The circuit inductance & The dynamic resistance in the circuit.	8	CO3	L4
b.	Explain Trigation gap method for triggering an impulse generator.	6	CO3	L2
c.	Derive an expression for the output impulse voltage.	6	CO3	L5
7 a.	Explain photo ionization phenomena in gas discharges.	6	CO4	L2
b.	Explain principle of operation of voltage doubler circuit to generate HVDC.	8	CO4	L2
c.	A Cockcroft – Walton type voltage multiplier has eight stages with capacitances all equal to 0.05 µF. The supply transformer secondary voltage is 125 kV at a frequency of 150 Hz. If the load current to be supplied is 5 mA, find; (i) The percentage ripple (ii) The regulation (iii) The optimum number of stages for minimum regulation.	6	CO4	L4
	or			
8 a.	Explain how surge current measurements are made using Klydonograph.	6	CO4	L2
b.	Explain how capacitance dividers are used to measure impulse voltage.	8	CO4	L2
c.	Explain the construction and working principle of series resistance microammeter for HVDC measurement.	8	CO4	L3

9 a.	Compare standard lightning impulse voltage with standard switching voltage.	5	CO5	L3
b.	Explain the construction and principle of operation of five stage marx impulse generator.	10	CO5	L2
c.	Briefly explain the factors affecting the discharge detection	5	CO5	L4
	or			
10 a.	Explain the high voltage Schering bridge used for capacitance and loss tangent measurements.	8	CO5	L2
b.	Explain the basic principle of PD measurement using straight detector method.	8	CO5	L2
c.	Discuss the various tests conducted on Insulators.	4	CO5	L3

Course Title: AC and DC Drives			
Course Code: P13EE73	**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

DC Drives Basic Concepts: Speed torque characteristics, starting, braking and speed control techniques of shunt/separately excited dc motor (theory only).

Rectifier controlled dc drives: Types of rectifiers- review, half wave, half &fully controlled rectifier fed dc drives, (separately &series dc motors) under continuous and discontinuous current mode, multi-quadrant operation of rectifier controlled dc drives. **10hr**

Unit – II

Converter fed Drives: Three phase half wave, half & fully controlled converter fed dc drives, dual converter fed drives.

Chopper controlled dc drives: Types of choppers – review, chopper controlled dc drives – motoring and braking operation, multi-quadrant operation of chopper controlled dc drives. **10hr**

Unit – III

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

Concept of dc motor braking: Methods of braking - regenerative, plugging and dynamic braking **10hr**

Unit – IV

AC Drives: Introduction, IM drives, Performance, Speed and Torque control methods: Stator voltage control, rotor voltage control, Stator frequency control, Voltage and frequency control, Current control, VSI fed IM drive, CSI fed IM drive, closed loop IM drive, Static Kramer drive, Static Scherbius drive and braking of IM. **12hr**

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, Cement mill drives, Paper mill drives, and Textile mill drives. **10hr**

Text Books:

1. “Electric drives” by G.K Dubey, Narosa publishing house, second Edition 2011.
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 Mc Graw 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. Explain and understand the various types of electric drives speed torque characteristics ,single phase converter fed dc drives with their operating characteristics to contol their speed.
2. Describe the Three phase converter fed dc drives with their operating characteristics to control their speed and to analyse the various types of chopper fed drives to achieve different quadrant operation.
3. Describe the basic concepts & requirements of closed loop drives and to derive the closed loop transfer functions and analyse the braking operation of Induction motor.
4. Explain and analyze the different methods of speed control used for Induction motor drives for variable speed applications.
5. Describe the principle operation of synchronous motor drives that are generally used and to describe and analyse the various stages of process involved in some manufacturing industries also analyse the types of motors used in various processes involved.

Model question paper

	UNIT - I	M	Blooms level	COs
1. a.	Draw the block diagram of electric drive and explain each components of it.	8	L1	CO1
b.	With the basic fundamentals Derive and explain the speed torque characteristics of dc shunt motors.	6	L2	CO1
c.	Explain and analyze the operation of single phase half controlled converter fed separately excited dc drive under discontinuous mode with relevant circuit and waveforms.	6	L5	CO1
2 a.	Explain and analyze the operation of single phase half wave converter fed separately excited dc drive under continuous mode with relevant circuit and waveforms.	6	L5	CO1
b.	Explain the four quadrant operating modes of separately exited DC motor and state the conditions to be satisfied for each quadrant.	8	L4	CO1
c.	With the basic fundamentals Derive and explain the speed torque characteristics of dc series motors	6	L2	CO1
	UNIT - II			
3 a.	Explain and analyze the operation of three phase half controlled converter fed dc series motor drive under discontinuous mode with relevant circuit and waveforms	10	L4	CO2
b.	Explain and analyze the operation of single phase dual converter with relevant circuit and waveforms with circulating current mode	10	L4	CO2
4 a.	Explain and analyze the operation of three phase fully controlled converter fed separately excited dc drive under continuous mode with relevant circuit and waveforms	10	L4	CO2
b.	Explain the operation of four quadrant chopper with the circuit diagram & operating characteristics.	10	L2	CO2
	UNIT - III			
5 a.	Derive an expression for closed loop control of a separately excited DC motor for change in voltage.	10	L2	CO3
b.	Explain in briefly the various types of breaking in DC motor.	10	L2	CO3
6. a	Derive an expression for closed loop control of a separately excited DC motor for change in load torque.	10	L2	CO3
b.	With the help of block diagram explain the closed loop control scheme for a DC drive using micro computer.	10	L4	CO3
	UNIT - IV			
7 a.	Derive & explain the performance equations of an IM Drive	10	L2	CO4
b.	With neat circuit and wave forms explain the operation VSI fed IM drive	10	L2	CO4
8 a.	Using (V/F)control principle explain how speed control for IM Drive	10	L2	CO4
b.	With Necessary Circuit and Speed Torque Curve explain the operation of static scherbius drive	10	L2	CO4
	UNIT - V			
9 a.	Explain the variable frequency control scheme for true synchronous mode of operation of synchronous motor drive	10	L2	CO5
b.	Draw the single line diagram and explain the various stages of operation in paper mill	10	L1	CO5
10 a.	With Necessary Circuit and waveforms explain the operation of self controlled synchronous motor drive employing load commutated inverter	10	L2	CO5
b.	Draw the single line diagram and explain the various stages of operation in rolling mill	10	L1	CO5

Course Title: : Utilization of Electrical Power			
Course Code : P13EE751	**Semester : VII**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture: 52 Hr. Exam 3 Hr		**Weightage: CIE:50%: SEE:50%**	

Prerequisites : The student is expected to have been exposed to fundamentals of Electrical Engg

Course Learning Objectives (CLO)

At the end of the course the students should have able to :

1. Analyze the various methods of electric heating and welding process. (L4)
2. Understand the working of various types of lamps and to evaluate lighting calculations. (L2)
3. Understand the working of electric traction system and its applications (L2)
4. Analysis of speed time characteristics of train movement (L4)
5. Applying the knowledge in electric traction, train movement, traction motors and electric braking (L3)

Relevance of the Course:

This course covers the comprehensive exposure to the various electrical utilities, analyze the concepts of various types of heating, welding Understand the laws of illumination and lighting calculation solve the illustrative examples on the same, analyze various types of electric traction and apply the knowledge in selecting electric motors for traction purpose.

Course Content

Unit – I

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

Unit – II

Illumination : Laws of illumination, light schemes, Design of lighting scheme,factory lighting, flood lighting, different types of lamps: Incandescent, mercury, arc, electric discharge lamps, mercury vapour lamps, fluorescent, vapour and CFL and their working **10 Hrs**

Unit – III

Electric Traction : Introduction, scheme of traction, types of electric traction, electric trains, systems of electrification for traction purposes: direct current, 1 phase AC system, composite system. Applications of systems for railway electrification. **10 Hrs.**

Unit – IV

Speed-Time Characteristics: Analysis of speed-time curve for electric train, tractive effort, specific energy output on the level track, various factors affecting energy consumption. **10 Hrs**

Unit – V

Traction Motors: Introduction, selection of traction motors, methods of speed control, energy saving by series-parallel method, AC traction equipment, AC series motor, characteristics, electric braking, regenerative braking on AC& DC series motor, linear induction motor and their use.**10 Hrs**

Text Books:

1.Electrical Power systems by Dr. S.L. Uppal , Prof. S Rao , Khanna Publishers

2. Power System Engineering by A Chakrabarti M.L. Soni , P.V. Gupta Bhatnagar, Dhanpat Rai & Co (pvt) Ltd., 2013

3.Utilization of Electrical power by R K Rajput, Laxmi publication

REFERENCE BOOKS:

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

Model Question paper

UNIT-I				
Q.No.	**Questions**	**Marks**	**CO**	**Blooms level**
1. (a)	Mention the advantages of Electric heating	4	CO1	L1
(b)	Describe the construction and working principle of an induction furnace	10	CO1	L3
(c)	Explain the different types of resistance welding	06		
OR				
2. (a)	Describe the construction and principle of working of an induction furnace	10	CO1	L3
(b)	A 20 kW single phase, 220 V resistance oven employs circular nickel chrome wire for its heating elements. If the wire temperature is not to exceed 1170^0 C and the temperature of the charge is to be 500^0 C. Calculate the length and size of wire required. Assume a radiating efficiency of 0.6 and specific resistance of the nickel-chrome $101.6x10^{-6}$ Ω cm .	06	CO1	L3
(c)	Explain the various methods of resistance welding	04	CO1	L2
UNIT-II				
3. (a)	Explain the law of illumination	06	CO2	L2
(b)	Define the following: i) Brightness ii)Polar curve iii)MSCP iv) Utilization factor	04	CO2	L1
(c)	Explain the construction and working principle of Sodium lamp	10	CO2	L2
OR				
4. (a)	A 250 V lamp takes a current 0.8 A it produces a total lux 3260 lumens calculate i) MSCP of the lamp ii) the efficiency of the lamp	04	CO2	L3
(b)	Explain the following : i) Factory lighting ii) Flood lighting	06	CO2	L2
(c)	Explain the construction and working principle of fluorescent lamp	10	CO2	L2
UNIT-III				
5.(a)	Explain the various types of traction system and mention the advantages and disadvantages	10	CO3	L2
(b)	Explain clearly systems of railway electrification	10		L2
OR				
6(a)	List the requirement of an ideal traction system	06	CO3	L1
(b)	State the advantages of electric traction over other non electric system of traction	06	CO3	L1
(c)	What are the merits and demerits of DC system of traction electrification	08	CO3	L1
UNIT-IV				
7(a)	Draw and explain a typical speed –time curve for an electric train movement	08	CO4	L3
(b)	Define crest speed , Schedule speed, coefficient of adhesion	06	CO4	
(c)	An electric train is to have acceleration and breaking retardation of 0.8 km/h/s and 3.2 km/h/s respectively. If the ratio of maximum to average speed is 1.3 and time for stop 26 seconds. Find the schedule speed from a run of 1.5 km. Assume simplified trapezoidal speed time curve	06	CO4	L3
OR				
8(a)	Derive an expression for the tractive effort developed by an train	10	CO4	L4

	unit.			
(b)	Derive an expression for specific energy output on level track using a simplified speed-time curve	10	CO4	L4
UNIT-V				
9 (a)	Discuss briefly desirable properties of traction motors	10	CO5	L3
(b)	Discuss the suitability of series motors for traction duties with the help of characteristics curve	10	CO5	L3
	OR			
10 (a)	Explain with the help of suitable circuit diagram i) shunt transition ii) bridge transition applied to a pair of D C traction motors	08	CO5	L2
(b)	What are the advantages and disadvantages of regenerative breaking as applied to traction	06	CO5	L1
(c)	Explain the control of single phase AC series motors	06	CO5	L2

Course Title: : Fuzzy Logic Control			
Course Code : P13EE752	**Semester : VII**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture: 52 Hr. Exam 3 Hr		**Weightage: CIE:50%: SEE:50%**	

Prerequisites: The student should have undergone the course on Digital electronics, Binary logic and Control system.

Course Learning Objectives (CLO)

This course aims to:

1. Form the Crisp sets and Fuzzy sets and to learn to implement Operations on Fuzzy Sets and fuzzy relations (L3).
2. Develop the Fuzzification methods and Defuzzification methods (L4).
3. To implement the approximate reasoning and develop the Fuzzy Inference Systems (FIS) (L4).
4. Analyze or Design a Fuzzy Logic Control (FLC) system**:** Introduction, Control system Design (L5).
5. Develop Fuzzy knowledge based controllers (FKBC)(L5).

Course Content

Unit-I

Classical / Crisp sets and Fuzzy sets: Classical sets and Operations on Classical Sets, Properties of Classical Sets; Fuzzy sets – Properties of Fuzzy sets, Operations in Fuzzy Sets.

Classical relations and fuzzy relations: Cartesian Product of Relations, Classical/Crisp relations, Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition. The Extension Principle **10 Hrs**

Unit-II

Membership functions: Introduction, Features of Membership Functions, Fuzzification, Methods of Membership Value Assignments, Defuzzification to Crisp sets, λ - Cuts (alpha –cuts) for Fuzzy Relations. Defuzzification methods – Max-membership principle, Centroid method, Weighted Average Method, Mean-Max membership, Center of Sums, and Center of Largest area, First and Last of Maxima. **10 Hrs**

Unit-III

Theory of approximate reasoning: Linguistic Variables, Linguistic Hedges, Fuzzy rule Based Systems, Fuzzy Proportions, Fuzzy if then Statements, Inference rules, Compositional rule of inference. Fuzzy Inference Systems (FIS) - Construction and Working Principals of FIS. Methods of FIS – Mamdani FIS, Sugino FIS, Takagi-Sugino fuzzy model. Comparison between Mamdani and Sugino method. **10 Hrs**

Unit-IV

Fuzzy Logic in Control Engineering: Introduction, Control system Design Problem, Fuzzy Logic Control (FLC) system Block Diagram - Architecture and Operation of FLC System. Examples of Control design. FLC System Models. Applications of FLC systems. **10 Hrs**

Unit-V

Fuzzy knowledge based controllers (FKBC): Basic concept structure of FKBC, Choice of Membership Functions, Scaling Factors, Rules, Fuzzyfication and Defuzzyfication Procedures. Simple Applications of FKBC. **10 Hrs**

Text Books:

1. Fuzzy Logic With Engineering Applications- TimotyRoss,John Wiley, Second Edition, 2009.
2.An Introduction to Fuzzy Control, by: D. Diankav, H. Hellendoom and M. Reinfrank Narosa Publishers India, 1996.

Reference books:

1. Fuzzy Sets Uncertainty and Information- G. J. Klir and T. A. Folger, PHI IEEE, 2009.

2. Essentials of Fuzzy Modeling and Control, R. R. Yaser and D. P. Filer,John Wiley, 2007.
3. Fuzzy Logic Intelligence Control And Information, Yen- Pearson education,First Edition,2006.

Course Outcomes

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

CO1: Apply the concepts of the fuzzy logic to practical problems and systems.

CO2: Apply the knowledge of the Fuzzification and Defuzzification methodsto implement fuzzy systems or Fuzzy control systems.

CO3: Apply the different reasoning methods and be able to develop Fuzzy Inference Systems (FIS).

CO4: Learn simple applications of fuzzy logic in Control Engineering and develop simple Fuzzy logic control systems (FLC)

CO5: To develop Fuzzy knowledge based controllers (FKBC)& to learn simple applications of FKBC.

Course Title: Electrical Distribution Systems			
Course Code: P13EE753	**Semester: VII**	**L-T-P-H: 4-0-0-4**	**Credits - 4**
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		**Weightage : CIE:50%; SEE:50%**	

Course Learning Objectives

1. Students will understand the Planning techniques, distribution, models, SCADA, automation.(L2)
2. Students will learn basic definition and load and load factor, load growth, substation location and substation location.(L3)
3. Students will understand system planning of Process, Criteria, Types of distributed energy resources, micro grid systems, Voltage stability analysis, Mapping, Calculations, and Automated Planning. (L3)
4. Students will learn how to measure Engineering Design, Operation Criteria, Energy Management, and Distribution System. (L4)
5. Students will learn the optimization Costing of Schemes, Planning Terms, Economic Loading of Distribution Transformers (L2)

Course Content

Unit-I

DISTRIBUTION SYSTEM PLANNING AND AUTOMATION: Introduction, factors affecting system planning, present planning techniques, future trends in planning, Role of computers in distribution planning, planning models, SCADA, Local energy control centre, typical control applications, systems approach, distribution automation. **10Hrs**

Unit -II

DISTRIBUTION SUBSTATION: Introduction, Load characteristics, Basic Definition, relation between load and load factor, load growth, substation location, rating of a distribution substation, substation service area with 'n' primary feeders, derivation of K constant, substation application curves, present voltage drop formula. **10hrs**

Unit-III

SYSTEM PLANNING: Planning Process, Planning Criteria, System Development, Introduction to distributed generation and control, Types of distributed energy resources (DER), Integration with grid and micro grid, communication in DER systems. Voltage stability analysis of distributed generation, distribution System Economics and Finance, Mapping, Modeling, System Calculations, Load Flow, Automated Planning. **10 Hrs**

Unit-IV

DESIGN AND OPERATION: Engineering Design, Operation Criteria, Sub-transmission Sub-station and Feeder, Voltage Control, Harmonics, Load Variations, System Losses, Energy Management, Model Distribution System **10 Hrs**

Unit-V

OPTIMIZATION: Introduction, Costing of Schemes, Typical Network Configurations, Planning Terms, Network Cost Modeling, Synthesis of Optimum Line Network, Economic Loading of Distribution Transformers, Worst Case Loading of Distribution Transformers.
10Hrs

TEXT BOOKS:

1. "Electric power distribution"-A S. Pabla, TMH, 5th edition, 2004.
2. "Electric power distribution system engineering", T. Gonen, McGrawHill, 1986.
3. "Electrical power distribution systems", V. Kamaraju. TMH New Dehli.

Course Outcomes (CO)

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

CO1: Analyses Distribution system planning and automation.

CO2: Understand Basic Definition relation between load and load factor, load growth distribution substation.

CO3: Understand system planning, Planning Process, Planning Criteria, System Development distributed generation and control.

CO4: Understand design and operation of Engineering Design, Operation Criteria, Sub-transmission and Sub-station systems.

CO5: Understand the optimization Costing of Schemes, Typical Network Configurations, Planning Terms, Network Cost Modeling of Distribution Transformers.

Course Title: Embedded Systems			
Course Code: P13EE754	Semester: VII	L-T-P-H: 4-0-0-4	Credits - 4
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		Weightage : CIE:50%; SEE:50%	

Course learning objective (CLOs):

1. Understand embedded system definition, classification, purposes and applications
2. Analyse hardware part of the embedded systems
3. Analysis of software co-design for an embedded system
4. Understanding IDE tool for troubleshoot of embedded system.
5. Understand the Real time operating system & Interrupts concepts

Course Content

UNIT-1

Introduction: What is an embedded system, Embedded VS General Computing Systems, Classification of Embedded Systems Major Application Areas of Embedded Systems, Purpose of embedded System.

Overview of embedded systems: embedded system design challenges, common design metrics and optimizing them. Processor Technology, IC Technology, Design Technology. **10 Hrs**

UNIT-2

The Typical Embedded System: Core of the Embedded System,Application Specific Integrated Circuits (ASICs),Programmable Logic Devices,Memory, Sensors & Actuators, The I/O Subsystem, Communication Interface: Onboard Communication Interfaces, External Communication Interfaces, Embedded Firmware, Other System Components **10 Hrs**

UNIT-3

Hardware Software Co-Design: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design: Data Flow Graph/Diagram (DFG) Model, Control Data Flow Graph/Diagram (CDFG), State Machine Model, Sequential Program Model, Concurrent/Communicating Process Model, Object Oriented Model, Unified Modeling Language (UML): UML Building Blocks, Things, Relationships, UML Diagrams, The UML Tools**.** **10 Hrs**

UNIT-4

The Embedded System Development Environment: Integrated Development Environment (IDE), An Overview of IDEs for Embedded System Development, Types of files generated on cross-compilation, Disassembler/Decompiler, Simulators, Emulators & Debugging, Target Hardware Debugging. **10 Hrs**

UNIT-5

Interrupts & RTOS: Basics - Shared Data Problem - Interrupt latency. Survey Of Software Architecture, Round Robin, Round Robin with Interrupts - Function Queues - scheduling - RTOS architecture. Introduction to RTOS : Tasks - states - Data - Semaphores and shared data - operating systems services - Massage Queues - Mail Boxes –Timers – Events - Memory Management. **10 Hrs**

Text Books:

1. Introduction to Embedded Systems: Shibu K V, Tata McGraw Hill,2010

2. Embedded System Design: A Unified Hardware/Software Introduction – Frank Vahid, Tony Givargis, John Wiley & Sons, Inc.2002

3. An Embedded software Primer- David E.Simon, Pearson Education, 1999

Reference Books:

1. Embedded Systems: Architecture and Programming, Raj Kamal, TMH.
2. Embedded C programming, Barnett, Cox &O'cull , Thomson (2005).

Course outcomes (COs):

1. Understand overview of an embedded system, its classificaiton, applications, design challenges & optimizations
2. Analyse hardware part such as ASIC, PLD, Memory, I/O, Communication interfaces
3. Analyse Fundamental Issues in Hardware Software Co-Design using various models and tools
4. Understanding various embedded systems IDE, compilation, Disassembler/Decompiler, Simulators, Emulators & Debugging,
5. Analysis of Interrupts and various RTOS Architecture and operating systems services

Course Title: Design of Analog Control System			
Course Code: P13EE761	**Semester: VII**	**L-T-P-H: 4-0-0-4**	**Credits - 4**
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		**Weightage : CIE:50%; SEE:50%**	

Course Learning Objectives:

- To introduce analysis of analog systems, and to design PID controllers and compensators for that plant in order to meet the required specifications.
- To make the students familiar with the significance and effects of each parameter of each controller/compensator, so that they'll instinctively able to determine which controller is best suited for the required application.
- To educate students about the benefits and necessity of State Space Design.
- To make students familiar with the Control Systems Toolbox in Matlab for analysis and design of control systems of any order.
- To educate students something about the optimal control design.

Course Content

UNIT-I

Introduction and Design using PI, PD, PID Controllers:
Introduction: Design specifications, Controller configurations, and fundamental principles of design. Design with the PD controller: time domain interpretation of PD control, frequency domain interpretation of PD control, summary of effects of PD control. Design with the PI controller: time domain interpretation and design of PI control, frequency domain interpretation and design of PI control. Design with PID controller. **12Hrs**

UNIT-II

Design using compensators: Introduction: classification of compensation, compensating networks-lead, lag, lag-lead. Polar & Bode plot of lead, lag, lag-lead compensators. Design of lead, lag and lag-lead compensators using Bode plot and Root locus method. Effects and limitations of lag, lead and lag-lead compensation. **12Hrs**

UNIT-III

Design of control systems in state space:
Introduction, Design by pole placement, Necessary and Sufficient Condition for Arbitrary Pole Placement, Determination of Matrix K using Ackermann's Formula, Regulator system and Control system, Choosing the Locations of Desired Closed Loop Poles, solving Pole Placement problems with MATLAB, Design of servo systems, Design of Type1 servo systems when the plant has an Integrator, Unit step-response characteristics of the Designed System. **10Hrs**

UNIT-IV

State observers:
Full-order State Observer, State observer Gain Matrix K using Ackermann's Formula, Effects of the Addition of the Observer on closed loop system, Transfer Function of the Observer-Based controller, Design of Regulator System with Observers **8 Hrs**

UNIT-V

Quadratic optimal regulator systems: Quadratic optimal regulator problems. Reduced order Riccati equation, Design steps using Reduced order Riccati equation. **8 Hrs**

TEXT BOOKS:

1) Automatic Control Systems, Benjamin.C.Kuo. PHI 7th& 8th edition,2002.

REFERENCE BOOKS:

1) Modern control systems, Katsuhiko Ogata. PHI 4th & 5th edition, 2010.
2) Control Systems- Principles and Design, M.Gopal,McGraw Hill, 4th edition,2012.
3) Control System Analysis and Design, A.K.Tripathi and Dinesh Chandra, New Age International (P) Ltd. First edition: 2009, Reprint: 2011.

Course Outcomes:

At the end of the course Students are able to

1. Analyze the stability and performance of a plant, and design a controller or compensator to ensure that the system meets the desired specifications.
2. To intuitively recognize which Poles and Zeroes need to be placed to obtain the desired performance.
3. Design the State Space Model for a given transfer function, with the corresponding State Feedback Gain Matrix and Observer Feedback Matrix.
4. To carry out analysis of any plant and control system given in Matlab.
5. To analyse about the optimal control design.

Course Title: : Testing and commissioning of Electrical Equipments			
Course Code : P13EE762	Semester : VII	L-T-P-H: 4-0-0-4	Credits:4
Contact Period: Lecture: 52 Hr. Exam 3 Hr		Weightage: CIE:50%: SEE:50%	

Prerequisites: The student should have undergone the course on Electrical Machines / Power Transmission and Distribution.

Course Learning Objectives (CLO)

At the end of the course the students should have able to :

1. Understand the concepts of installation of Transformers i.e. location, site selection, rating of machine, enquiry and storing of dispatched machine. And analyze different test which are conduct before commissioning of a transformer. (L2,L4)
2. Understand the concepts of installation of synchronous machine i.e. foundation details, cooling arrangements, excitation. And analyze different test which are conduct before commissioning of a synchronous machine. (L2,L3)
3. Understand the concepts of installation of Induction motor i.e. foundation details, alignment, coupling (L2)
4. Analyze different test which are conducted on circuit breaker and its maintenance. (L4)
5. Analyze the different safety measures. (L4)

Relevance of the Course:

This course covers the knowledge of how to install transformers, synchronous machines, Induction machines, circuit breakers. What are the different test should be conducted before installing a machine, it gives the knowledge of knowing different rating of machine, procurement process, installation and commissioning of electrical machines.

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. **12 Hrs**

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, waveform & telephone interference tests, line charging capacitance.

Performance tests: Various tests to estimate the performance of generator operations, slip test, maximum lagging current, maximum reluctance power tests, sudden short circuit tests, transient & sub transient parameters, measurements of sequence impedances, capacitive reactance, and separation of losses, temperature rise test, and retardation tests.

Factory tests: Gap length, magnetic eccentricity, balancing vibrations, bearing performance

10 Hrs

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.

10 Hrs

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 **10 Hrs**

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. **10 Hrs**

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,
3. Transformer & Switch Gear Handbook -Transformers-BHEL, J &P, J & P

Model Question paper

UNIT-I				
Q.No.	**Questions**	**Marks**	**CO**	**Blooms level**
1.(a)	Explain the various accessories of power transformer	10	CO1	L2
(b)	What is drying out of transformer . Explain different methods of drying out of a transformer	10	CO1	L2
OR				
2. (a)	State the various commissioning test on power transformer	10	CO1	L2
(b)	Explain impulse testing on transformer	10	CO1	L2
UNIT-II				
3.(a)	List the steps involved in Installation of an alternator	05	CO2	L2
(b)	Explain the procedure of drying out of synchronous machines	05	CO2	L2
(c)	Explain different methods of cooling of turbo generator	10		L2
OR				
4. (a)	Explain the sudden 3 phase short circuit test on generator	05	CO2	L2
(b)	Explain the open circuit test on synchronous generator	05	CO2	L2
(c)	Explain the procedure of measurement of dc resistance of windings in alternator	10	CO2	L2
UNIT-III				
5.(a)	What are the information to be given with enquiry and placing the order for induction motor	10	CO3	L1
(b)	Explain the foundation details used for induction motor	10	CO3	L2
OR				
6(a)	What are the different methods of drying out of an induction motor ? Explain.	10	CO3	L2
(b)	How temperature test is carried out in induction motor	05	CO3	L1
(c)	Explain blocked rotor test on induction motor	05	CO3	L2
UNIT-IV				
7(a)	List the different test to be conducted on a circuit breaker	10	CO4	L1
(b)	Expalin fifferent the routine test conducted on CTs	05	CO4	L2
(c)	How mechanical test is conducted on circuit breaker	05	CO4	L1
OR				
8(a)	Mention the possible troubles, causes and corrective actions for out door circuit breaker	10	CO4	L1
(b)	List the specifications of high voltage circuit breaker	05	CO4	L2
(c)	Enumerate type test conducted on CTs	05	CO4	L3
UNIT-V				
9 (a)	State the seven principles of safety management	10	CO5	L2
(b)	Explain the safety management interface with O and M	10	CO5	L2
OR				
10 (a)	Mention the Recommend safety precautions against electrical shock in small building, shops and LV stations.	10	CO5	L2
(b)	State and explain the principles of live line working	10	CO5	L2

Course Title: Soft Computing Techniques			
Course Code:P13EE763	**Semester: VII**	**L-T-P-H: 4-0-0-4**	**Credits – 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50%; SEE:50%**	

Prerequisites: The student should have undergone the courses on computers and computer programming.

Course Learning Objectives (CLO)

This course aims to:

1. Learn and implement about Neural Networks and back-propagation algorithms (L3).
2. Learn about implementation of different neural networks viz., Bidirectional associative memory (BAM) and Adaptive Resonance theory (ART) algorithms (L4).
3. To implement the Fuzzy Logic systems and their applications (L4).
4. Analyze and design various Genetic Algorithms for different applications (L3)
5. Learn and design or develop Hybrid Systems consisting of both fuzzy neural networks and genetic algorithms (L5).

Course Content

Unit-I

Introduction:

Introduction to Artificial Intelligence systems. Soft computing (SC) methods – principal constituents of SC - Neural networks, Fuzzy logic, Genetic algorithms and other hybrid systems**.**

Neural Networks

Fundamental of neural networks and human brain; neural net architectures - single layer, multi layer feed forward networks and recurrent networks, learning methods, early neural net work architecture – perceptron, adaline, madaline network; some application domains.

Back propagation (BP) networks: Architecture of BP network, Back propagation learning, Illustration, Various standard back propagation algorithms. **10Hrs**

Unit-II

Associative memory: Autocorrelators, Heterocorrelators – Kosko's discrete Bidirectional associative memory (BAM), exponential BAM, algorithm and applications.

Adaptive Resonance theory (ART): Introduction – cluster structure, vector quantization, classical ART networks. ART1 – architecture, special features, algorithm, illustration. ART2 – architecture, algorithm, illustration; applications **10Hrs**

Unit-III

Fuzzy Logic

Fuzzy set theory: Fuzzy sets – membership functions, fuzzy basic operations, properties of fuzzy sets, fuzzy relations – fuzzy Cartesian product, operations on fuzzy relations.

Fuzzy systems: Crisp logic – Laws of propositional logic, inference in propositional logic, Predicate logic – interpretations of predicate logic formula, inference in predicate logic; Fuzzy logic – fuzzy quantifiers and fuzzy inference; fuzzy rule based system, defuzzification methods; applications.

10**Hrs**

Unit-IV

Genetic Algorithms

Fundamentals of Genetic algorithms (GA): History, basic concepts, creations of offsprings, working principle, Encoding methods - binary, octal, hexadecimal permutation, value, tree encoding; Fitness function, Reproduction - selection methods – Roulette-wheel, Boltzsman, tournament, Rank and steady state selection.

Genetic Modeling: Inheritance operators, Cross over methods – single site, two- point, multi-point, uniform, matrix cross over methods. Inversion and deletion methods; Mutation operator, bitwise operators, convergence of GA. Applications of GA. **10Hrs**

Unit-V

Hybrid Systems

Integration of Neural networks, Fuzzy logic, and genetic algorithms: Hybrid systems – sequential, auxiliary and embedded hybrid systems; neural networks, fuzzy logic, and genetic algorithms hybrids – Neuro-fuzzy hybrids, Neuro-genetic hybrids, fuzzy-genetic hybrids. Over view of hybrid systems viz., GA based BP networks, Fuzzy-BP network, simplified ARTMAP, Fuzzy Associative Memories, Fuzzy logic controlled genetic algorithms. **10Hrs**

Text books:

1. Neural networks, Fuzzy logic, Genetic algorithms: Synthesis and Applications. By: S.Rajashekaran, G.A. VijayaLakshmipai. PHI Learning Pvt Ltd. publications , year 2010.

Reference Book:

1. Principles of Soft Computing, By: S.N.Shivanandam, S.N.Deepa., Wiley India (pvt) Ltd publications. First edition 2007

Course Outcomes

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

CO1: Apply the concepts of the artificial neural networks (ANN) to practical problems and systems.
CO2: Apply the knowledge of the different ANN viz., Bidirectional associative memory (BAM) and Adaptive Resonance theory (ART)algorithms and applications.
CO3: Apply the knowledge of Fuzzy set theory and be able to develop Fuzzy Inference Systems.
CO4: Learn and implement the simple applications of Genetic Algorithms.
CO5: To develop hybrid systems consisting of neural network, fuzzy logic and genetic algorithms & learn to simple applications of hybrid systems.

Course Title: Data Base Management System			
Course Code: P13EE764	Semester: VII	L.T.P.H:4-0-0-4	Credits:4
Contact Period: 50Hrs., Exam 3 Hrs		Weightage: CIE:50% ; SEE:50%	

Course Learning Objectives (CLOs)

This course aims is to:

1. To expose the students to the fundamental concepts necessary for designing, using, and implementing database systems and applications.
2. To make the students to become well-grounded in basic concepts necessary for understanding data base and their users, DBMS concepts, architecture.
3. To familiarize the students with ER diagrams. To expose the students to SQL.
4. To familiarize the students with the different types of databases and security issues in databases.
5. To make the students to understand the fundamentals of transaction processing and Query processing

Course Content

UNIT-I

Introduction to data base systems: Managing data, a historical perspective, File systems versus DBMS, Advantages of DBMS, Describing and Storing Data in DBMS, Queries in DBMS, Transaction management, Structure of DBMS, People who work with databases.**Entity-Relationship Model:**Using high-Level Conceptual Data Models for Database Design, An example of Database Application, Entity types, Entity Sets, Attributes and Keys, Relationship types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design for the COMPANY database, ER Diagrams, Naming Conventions and Design Issues. **10Hrs**

UNIT-II

Relational model and relational algebra: Relational model concepts, relational model constraints and relational database schemes, update operations and dealing with Constraint Violations, Unary relational Operations, SELECT and PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations, JOIN and DIVISION, Additional Relational Operations, examples of Queries in Relational algebra, relational database design using ER – to-Relational mapping. **10Hrs**

UNIT-III

SQL-The Relational Database standard: SQL Data definition and data types, specifying basic constraints in SQL, Schemes, Change statements in SQL, basic Queries in SQL, more complex SQL queries, Insert, Delete and update statements in SQL, additional features of SQL, specifying general constraints as assertion, views (virtual tables) in SQL, database Programming, issues and Techniques, Embedded SQL, Dynamic SQL. **10Hrs**

UNIT-IV

Database Design: Informal Design Guidelines for Relation Schemes, Functional Dependencies, Normal Forms based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Properties of Relational Decompositions, Algorithms for Relational Database Scheme Design, Multivalved Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Inclusion Dependencies, Other Dependencies and Normal Forms.

Database Security: Introduction Security, Access control, Discretionary Access, Mandatory Access Control**.** **10Hrs**

UNIT-V

Transaction Management: The ACID properties, Transactions and Schedules, Concurrent Execution of transactions, Lock-based Concurrency control, performance of locking, Transaction support In SQL, Introduction to crash recovery; 2PL, serializability and recoverability, Introduction to lock management, Lock Conversions, Dealing with Deadlocks, Specialized locking Techniques, Concurrency control without locking, Introduction to ARIES, The log, Other Recovery related Data Structures, The write-ahead log Protocol, Check pointing, Recovering from a System Crash, Media Recovery, Other Algorithms and Interaction with Concurrency control. **10Hrs**

TEXT BOOKS:-

1. "Database Management Systems", Raghu Ramakrishnan and Johannes Gehrke, 4th Edition, McGraw Hill, 2007.
2. "Fundamentals of Database Systems" and Navathe, 4th Edition Pearson Education, 2003

REFERENCES:-

1. "Database Systems Concepts", A. Silberschatz, H. Korth and S. Sudarshan, McGraw Hill.6th Edition, 2011.
2. "An Introduction to Database Systems", R. Ramakrishnan and J. Gehrke, McGraw Hill
3. "An Introduction to Database Systems", C. J. Date, Addison Wesley. 8th Edition.
4. "Database Management System", G.K.Gupta, Tata McGraw Hill, 2011.

Course Outcomes

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

CO1. Understand user requirements/views and analyse existing and future data processing needs. Develop and refine the conceptual data model, including all entities, relationships, attributes, and business rules and integrate and merge database views into conceptual model

CO2. Understand the Relational model concepts, constraints, database schemes Relational Algebra operations and Design using ER-to Relational mapping.

CO3. Understand SQL, types, constraints, Schemes, Queries, Database Programming.

CO4. Understand Functional dependencies, Algorithms for Database Scheme design, apply normalization techniques identify data integrity and security concepts to databases.

CO5. Apply concurrency control and recovery mechanisms for practical problems and design Query processor and transaction processor.

Course Title: Computer Aided Electrical Drawing (CAED)			
Course Code:P13EEL74	Semester: VII	L-T-P-H: 2-0-3-5	Credits – 3
Contact period : Lecture: 36Hrs, Exam 3 Hrs		Weightage : CIE:50%; SEE:50%	

Course Learning Objectives (CLOs)

This course aims to

1. Students should be able to draw single line diagram.
2. Students should be able to develop the AC and DC Winding diagrams.
3. Students should be able to draw the elevation of transformer and DC Machine.

Course Content

1. Draw Single Layer Diagrams of generating station and substation.
2. Draw layout diagram of Hydro, Thermal and Nuclear power plant.
3. Develop winding diagrams of D.C. machines Simplex single layer Lap and wave winding.
4. Develop winding diagrams of D.C. machines Simplex double layer Lap and wave winding.
5. Develop winding diagrams of D.C. machines Duplex single layer Lap and wave winding.
6. Develop winding diagrams of D.C. machines Duplex double layer Lap and wave winding.
7. Develop winding diagrams of A.C. machines Integral slot full pitched single layer Lap and Wave windings.
8. Develop winding diagrams of A.C. machines Integral slot full pitched Double layer Lap and Wave windings.
9. Develop winding diagrams of A.C. machines Fractional pitched full pitched single layer Lap and Wave windings.
10. Develop winding diagrams of A.C. machines Fractional pitched full pitched single layer Lap and Wave windings.
11. Draw the Electrical machine assembly drawing for single and three phase core type transformer.
12. Draw the Electrical machine assembly drawing for single and three phase shell type transformer.

Course outcome:

CO1. Draw the single line diagram of Generating station, Receiving station and Substation.
CO2. Design the AC and DC windings in Lap and Wave winding.
CO3. Develop the Electrical machine assembly drawings.

Text Book:

1. 1.Performance& Design of Alternating Current machines, M. G. Say, CBS publishers,3rd Edition,2002.
2. 2.The Performance & Design of DC machines A.E Clayton & N.N.Hancock CBS Publication,3rd Edition,2004.

Reference Books:

1. Electrical Drafting – S F Devalapur.,Eastern Book Promoters, Belgaum, 2006.
2. Manuals of Auto – CAD

Course Title : Power System Simulation Lab			
Course Code : P13EEL77	Semester : VIII	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. Simulate experiments for formation of Y bus, by inspection method and singular transformation method and Analyze the bus currents, bus power and line flows for a given bus .
2. Determine the fault currents and voltages in a single line transmission line for SLG, LL,DLG fault
3. Determine power angle diagram of salient and non salient pole synchronous machine
4. Determine Swing curve critical clearing time for a single bus machine connected to infinite bus
5. Analyze the load flow studies by different methods.

Course Title : Relay and High Voltage Laboratory			
Course Code : P13EEL78	**Semester : VIII**	**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 conduct practical experiments on Relay and High voltage equipments; 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 and high frequency voltage generator.

C. Self-study experiment

Course Outcomes

Student will be able to

6. Conduct experiments on over voltage & over current relay
7. Analyze the fault between phase to phase, phase to neutral & phase to earth in merz price & feeder protection scheme.
8. Understand spark over characteristics of air insulation subjected to HVAC & HVDC for uniform and non uniform fields
9. Determine 50% probability flashover voltage using impulse generator
10. Conduct Partial Discharge experiments for different insulation at different pressure

VIII Semester

Course Title: Energy Auditing & Demand Side Management			
Course Code: P13EE81	**Semester: VIII**	**L-T-P-H: 2-2-0-4**	**Credits - 3**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		**Weightage : CIE:50%; SEE:50%**	

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

Unit 1

Introduction: Energy situation in the world and India, Energy consumption, Conservation, The power flow concept. Codes, standards and Legislation.
Energy Economic Analysis: The time value of money concept, Developing cash flow models, payback analysis, depreciation, taxes and tax credit, Concept of ABT.numerical problem **10Hrs**

Unit 2

Energy Auditing: Introduction, Elements of energy audits, energy use profiles, measurements in energy audits, case studies, presentation of energy audit results. **10Hrs**

Unit 3

Electrical Equipment and power factor correction: location & sizing of capacitors, energy efficient motors, lighting basics, Numerical on power factor correction **10Hrs**

Unit 4

Demand Side Management: Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning.Tarriff option for DSM, customer acceptance of DSM **10Hrs**

Unit 5

Load management: Load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, promotion of high efficient technologies, DSM implementation issues, Management and Organization of Energy Conservation awareness Programs. **10Hrs**

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"-JyothiPrakash, , 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

At the end of this course students should have knowledge in the following
CO1: Energy situation in the world and in India. Power flow concepts, Codes, Standards and Legislation, Time value of money concept, Developing cash flow models, Payback analysis, taxes and tax credits, concept of ABT.
CO2: Elements of energy audit, presentation of energy audit results, measurements in energy audit.
CO3: Power factor correction, energy efficient motors and lighting basics.
CO4: Concept of DSM, benefits of DSM, Different techniques of DSM.
CO5: Managing the available load wrt demand with different techniques, awareness program for energy conservation.

MODEL QUESTION PAPER

Q.No.	Questions	Marks	CO	Blooms level
1.a)	Discuss the energy scenario in the world and in India.	12	CO1	L2
b)	Which are the issues addressed by Energy conservation Act ?	08	CO1	L1
	OR			
2.a)	What is time value of money concept? What are the different cash-flow models?	04	CO1	L1
b)	Explain the pay back analysis.	04	CO1	L2
c)	Calculate the depreciation rate using the (i) Straight-line, (ii) Sum-of-years digit and Salvage is Rs.0 Life of the equipment, n = 5years Initial expenditure p = Rs. 150000 For declining balance use a 200% rate.	08	CO1	L3
3.a)	Define energy audit. Explain the importance of energy audit in industry.	7	CO2	L1
b)	Explain the detailed energy audit activities.	5	CO2	L2
c)	Explain the different steps of presenting the energy audit results.	8	CO2	L2
	OR			
4.a)	Give the 10 methodology steps for detailed energy auditing explain	10	CO2	L1
b)	what is energy use profile? What are the audits required for constructing the energy use profile?	10	CO2	L1
5.a)	Derive an expression for most economical power factor considering constant active Power. Draw relevant Vector diagram.	10	CO3	L3
b)	A load of 500 kW at 0.8 pf is taken by an industrial user. The tariff plan is: Rs.400/kVA of Maximum Demand per annum + Rs.1.00 per unit of Energy consumed. The cost ofinstallation of capacitor bank for pf Improvement is Rs.600 per kVAR and has an annual interest and Depreciation of 11%.find: i)Most economical pf ; ii)Rating of capacitor bank to increase power factor to value calculated in (i). iii) Annual saving in energy bill.	10	CO3	L3
	OR			
6.a)	Explain the calculation of power factor correction.	8	CO3	L2
b)	An alternator in supplying a load of 300KW at a p.f. of 0.6 lagging. If the power factor is raised to Unity, how many more KW can the alternator supply for the same KVA loading?	6	CO3	L3
c)	Write a note on energy efficient motors .	6	CO3	L2
7.a)	what is DSM? what is scope of DSM? how did the concept of DSM evolve?	10	CO4	L1
b)	Explain the various steps in DSM planning and implementation.	10	CO4	L2
	OR			
8.a)	Discuss tariff options for DSM. which tariffs promote DSM?	10	CO4	L3
b)	Explain peak clipping, vally filling and strategic energy conservation	10	CO4	L2
9.a)	Explain the load management as DSM strategy.	8	CO5	L2
b)	Explain energy conservation opportunities in illumination systems.	6	CO5	L2
c)	with a flow chart, explain corporate level organization of energy conservation programme.	6	CO5	L3
	OR			
10.a)	What is time of –day pricing? With the help of suitable example, explain how this helps in an efficient DSM.	10	CO5	L2
b)	with a flow chart, explain Plant level and Division level organization of energy Conservation programme.	10	CO5	L3

Course Title: Power System Operation and Control			
Course Code: P13EE82	Semester: VIII	L.T.P.H: 2-2-0-4	Credits:03
Contact Period: Lecture:52Hrs., Exam 3 Hrs	Weightage: CIE:50%; SEE:50%		

Prerequisites: The student should have undergone the course on Power Transmission & Distribution, Power System Analysis, and Linear Control systems

Course Learning Objectives (CLOs)

This course aims to:

1. Provide the adequate knowledge of the functions of energy control center, SCADA systems and the security control (L3).
2. Have an insight into the role of speed governing mechanism in load frequency control, concept of control area, modeling and analysis of load frequency control loop (L3).
3. Understand the mechanisms involved in maintaining the frequency constant by controlling the real power, when there is a system load variation (L4).
4. Explain the methods of voltage control to maintain the voltage constant (L3).
5. Explain the economic scheduling of load among the generators and the concept of economic dispatch and learn to solve about the Unit Commitment problems (L4).
6. Solve Power System Security problems (L5).

Relevance of the Course

The aim of the course is to make the students become familiar with the power system operation and control, to meet the variations of system load. Preparatory work is necessary for understanding the economic operation of the power system and the various control actions to be implemented on the power system to meet the minute – to -minute variation of system load.

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.
10 Hrs

Unit – II

Automatic Generation Control: Automatic control loops of generators: AGC and AVR. Automatic Load Frequency Control (ALFC/LFC), ALFC of single area systems, Concept of control area, multi-area systems, Pool operation-two area systems. **10 Hrs**

Unit – III

Control of voltage and Reactive Power: Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, Single machine infinite bus systems, methods of voltage control, Voltage stability, and Voltage collapse. **10 Hrs**

Unit –IV

Unit Commitment: Statement of the problem, need and importance of unit commitment, Methods of Unit commitment -priority lists method, constraints, spinning reserve, and examples. **10 Hrs**

Unit –V

5.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. **10 Hrs**

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.“ModernPowerSystemAnalysis”,by: D.P.KothariandI.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 concepts of the functions of energy control center, SCADA systems.
CO2: Apply the knowledge of the role of speed governing mechanism in load frequency control, concept of control area, modeling and analysis of load frequency control
CO3: Compare the different methods of voltage control to maintain the voltage constant.
CO4: Determining economic scheduling of load among the generators, and the concept of economic dispatch and Unit commitment problems
CO5: Ability to solve problems based on Power System Security.

SI.NO	Model Question Paper	Marks	CO's	Levels
PART - A				
1.a)	Explain with a neat block diagram the digital computer configuration of the SCADA systems.	10	CO1	L1
b)	Derive the expression for Tie line power flow and frequency deviation for two area system.	06	CO1	L3
c)	Two areas A & D are inter connected by a tie line. The generating capacity of area 'A' is 36,000MW and its regulating characteristic is 1.5% of capacity per 0.1 Hz. Area 'D', has a generating capacity of 4,000 MW and its regulating characteristic is 1% of capacity per 0.1 Hz. Find the each area's share of +400 MW disturbance (load increase) occurring in area 'D' and the resulting tie–line flow.	04	CO1	L4
2.a)	Explain with a neat diagram, the turbine speed governing system for turbo generators and obtain (derive) the mathematic model of the speed governing system for AGC.	10	CO2	L3
b)	Two generators are rated 200 MW and 400 MW are operating in parallel. The droop characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming that the generators are operating at 50 Hz at no load, how would load of 600 MW be shared between them? What will be the system frequency at this load? Assume free governor action operation. Repeat the problem, if both governors have a droop of 4%.	10	CO2	L4
3.a)	Draw and explain the complete Block diagram representation of single control area having a turbo – generator supplying an isolated load, for load frequency (LFC) problem. Discuss the response of the system for a sudden change demand.	10	CO2	L2
b)	Determine the primary ALFC loop parameters (Kp and Tp) for a control area having the following data: Total area capacity, Pr= 2000MW, Normal operating load, P_D^0 = 1000 MW, Inertia constant = 5.05, frequency, f^0 = 60 c/s, Regulation, R = 2.4 Hz/pu MW	05	CO2	L4
c)	What is the object of using PI – controller in LFC? How is it useful to the system?	05	CO2	L3
4.a)	Show that the power flow between two nodes is determined largely by the transmission angle and the flow of reactive power is determined by the scalar voltage difference between two nodes.	06	CO3	L2
b)	Discuss the following methods of voltage control in a power system: (i) Injection of reactive Power, (ii) Tap-changing Transformer.	08	CO3	L2
c)	In a radial transmission system shown in fig.Qn.4(c) all p.u. values are referred to the voltage buses shown and 100MVA. Determine the power factor at which the generator must operate.	06	CO3	L4
Part-B				
5.a)	Explain and discuss the problem of unit commitment in optimal power system operation. What are the constraints in solving the unit commitment problem?	10	CO4	L2
b)	Explain briefly any one method of solving unit commitment problem with suitable example	10	CO4	L4
6.a)	Discuss the factors affecting power system security	10	CO5	L2
b)	What are credible contingencies? Explain any one method of analyzing such contingencies.	10	CO5	L4
7.a)	Explain the calculation of network sensitivity factors	10	CO5	L2

b)	Explain how contingency analysis helps the power system engineer for control and operation of power system	10	CO5	L2
8.	Write short notes on any **four** of the following:	5m x4 = 20		
	(i) Spinning reserve (ii) Priority list method (iii) Functions of Energy control Centre (ECC) (iv) Parallel operation of generators (v) Generation and absorption of reactive power (vi) Voltage stability and voltage collapse			

Course Title: Modern Power System Protection			
Course Code: P13EE831	**Semester: VIII**	**L.T.P.H: 2-2-0-4**	**Credits : 3**
Contact Period: Lecture:52Hrs., Exam 3 Hrs		**Weightage: CIE:50%; SEE:50%**	

Prerequisites: The student should have undergone the course on Switchgear Protection

Course Learning Objectives (CLOs)

This course aims to:

1. To understand the basic construction, classification and related circuits needs for protection(L2)
2. To develop different characteristics of comparators and build different types of comparators(L3)
3. To understand numerical protection system with block diagrams(L2)
4. To develop different types static over current, timer and voltage relays(L5)
5. To analyze different characteristics used in distance relays and to estimate distance relay settings (L4)
6. To develop different types of microprocessor based digital relays(L5)

Course Content

UNIT -1

STATIC RELAYS: Introduction, Basic construction, Classification, Basic Circuits, Smoothing Circuits, Voltage regulation, square wave Generator, Time delay Circuits, Level Detectors, Summation device, Sampling Circuits, Zero crossing detector, output devices.

COMPARATORS: Replica impedance, Mixing Transformers, General equation of Amplitude comparator. **10 Hrs**

UNIT-2

COMPARATORS: General equation of Phase comparator.Realization of ohm, mho, Impedance and offset impedance characteristics; Duality principle; Static amplitude comparator – Rectifier bridge circulations current type, sampling comparator, Static phase comparator - coincidence circuits type rectifier phase comparator, Block spike comparator, Zener diode phase comparator **10 Hrs**

UNIT-3

PRINCIPLES OF DIGITAL/ NUMERICAL RELAYS: Definition of Numerical Protection System, Advantages of Numerical relays, Block diagram of Numerical Relays, Processing Unit, Man machines Interface, Communication in protective relays, Information handling with sub station monitoring system.

DIGITAL RELAYS: Block Schematic approach of microprocessor based relays, Over current relay protection, Transformer differential protection, Directional relay scheme, Impedance relay scheme. **12 Hrs**

UNIT-4

STATIC OVER CURRENT, TIMER AND VOLTAGE RELAYS: Instantaneous over current Relay, Definite time lag relay, Inverse time over current relay, static timer relay, Basic delay circuits, Monostable delay circuits ,Single phase Instantaneous over voltage and under voltage relays, Instantaneous over voltage relay using Op-amp. **10 Hrs**

UNIT-5

DISTANCE RELAY: General principle of operation, Zone discrimination, Fault area on impedance diagram, Basic measuring elements, Different characteristics used in distance relaying- Impedance, Reactance, Admittance, Ohm ; Distance relay settings, Distance measurement Problems. **10 Hrs**

Text Books:

1. Power System Protection, Static Relays with Microprocessor applications"- T.S. Madava Rao, TMH, Second editon, 2009.
2. Protective Relays and Protection -Van Warrington A. R. and Van C, Vol, I & II Chapman and Hall, 1968.

Reference Books:

1. Power System Protection, Patra. S.P. Basu. S.K. Choudhari.S. Oxford, and IBH Publications Co-1983.

3. Power System Protection and switchgear,Ravindranath. B and Chanda M. New age International, Second editon, 2014
4. Power system protection and switchgear,B.Ram and D.N Vishwa karma- TMH, Second editon, 2011
5. Fundamentals of Power System Protection,Y.G. Painthankar. S.R. Bhide PHI, Second editon,2013

Course Outcomes

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

CO1: Select various types of circuits needed for digital relay operation and analyze general equations for amplitude comparator

CO2: Analyze the different characteristics of phase and amplitude comparators and to understand various types of comparators

CO3: Understanding the principle of numerical relay protection system and develop microprocessor based relay

CO4: Develop different types of static over current, timer and voltage relays

CO5: Understand & analyze distance relay operation with characteristics and study distance relay settings

SI.NO	Model Question Paper	Marks	CO's	Levels
	UNIT-I			
1.a)	Describe the construction of static protective relays with block diagram.	10	CO1	L2
b)	Name different types of state relays. Discuss the use of Hall crystals as state relays	06	CO1	L1
2.a)	Derive a general equation for an Amplitude comparator and obtain MHO characteristics from it.	10	CO1	L4
b)	Discuss the role of replica impedance and mixing transformers used in comparators	10	CO1	L2
	UNIT-II			
3.a)	Derive ohm relay and directional characteristic of phase comparator	10	CO2	L4
b)	Explain duality principle between phase and amplitude comparator	10	CO2	L4
4.a)	Explain the circulating current type rectifier bridge amplitude comparator	10	CO2	L2
b)	Explain the principle of operation of zener diode phase comparator	10	CO2	L2
	UNIT-III			
5.a)	Explain the principle of operation of numerical relay with block diagram	10	CO3	L4
b)	Explain microprocessor based over current rely protection scheme	10	CO3	L4
6.a)	Discuss the processing unit and man machine interface in numerical relays	10	CO3	L2
b)	Explain directional relay scheme used in digital relays	10	CO3	L4
	UNIT-IV			
7.a)	Discuss the construction and principle of operation of static instantaneous overcurrent relay	10	CO4	L4
b)	Discuss the construction and principle of operation of static instantaneous overvoltage relay using op-amp	10	CO4	L4
8.a)	Discuss the construction and principle of operation of static inverse time overcurrent relay	10	CO4	L4
b)	Discuss the construction and principle of operation of static overvoltage and undervoltage relay	10	CO4	L4
	UNIT-V			
9.a)	Explain the principle of operation of three step zone discrimination used in distance relays	10	CO5	L2
b)	Discuss the reactance and admittance relay characteristics used in distance relays	10	CO5	L3
10.a)	Discuss fault area on impedance diagram used in distance relays	10	CO5	L2
b)	Explain zone-1, zone-2 and zone-3 settings used for distance relay operation	10	CO5	L3

Department of Electrical & Electronics Engineering

Course Title: Advanced Electrical Machines			
Course Code:	**Semester:**	**L-T-P-H: 2-2-0-4**	**Credits - 3**
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		**Weightage : CIE:50%;**	

Course Learning Objectives (CLOs)

This course aims to:

1. To understand about the generalMachine theory.
2. To understand the concept of linear transformations.
3. To understand basic types of DC machines with block diagrams
4. To understand the concept of reference frame theory applicable to machines
5. To understand the concept of voltage equations with respect to synchronous machines.

Course content

Unit-I

General Machine theory: Basic machine, conventions, basic 2-pole model, diagrams of DC and AC machines, Kron's Primitive Machine, Voltage equation, Torque Equation, applications of GM theory, restrictions involved **10 Hrs**

Unit-II

Linear transformations in machines: Power invariance, transformations from: displaced brush axis, 3-phases to 2-phases, rotating axes to stationary axes; Transformed impedance matrix. **10Hrs**

Unit-III

Theory of DC machines: Introduction, voltage and torque equations in machine variables, basic types of DC machines, Block Diagrams of DC Machines **10 Hrs**

Unit-IV

Reference Frame theory: Introduction, equations of transformations, change of variables, stationary circuit variables transformed to the arbitrary reference frame, commonly used reference frames, transformation between reference frames.

Theory of induction machines: voltage equations in machine variables, Torque equation in machine variables, equations of transformation for rotor circuits, commonly used reference frames. **10Hrs**

Unit-V

Theory of synchronous machines: voltage equations in machine variables, Torque equation in machine variable, stator voltage equations in arbitrary reference frame variables and voltage equations in rotor reference frame variables- Park's equations.

Linearization of machine equations, reduced order equations, brief discussion on unbalanced induction machine operations: typical unbalanced rotor and stator conditions**.**

10Hrs

Text Books:

1. "Analysis of Electrical Machinery", Paul C. Krause, McGraw Hill Book Company. (International edition- 1987),
2. **"**Generalized Circuit Theory of Electrical Machines", P.S. Bhimbhra, Khanna Publishers, Delhi-6. (First Edition: 1975)

Reference Books:

1. Analysis of Electric Machinery and Drive Systems, P. C. Krause, Oleg Wasynczuk and Scott D Sudhoff, 2nd Edition, IEEE – Wiley Press, 2002.

Course Outcomes

1. To understand the model diagrams of machines
2. To understand the concept of linear transformations.
3. To understand the concept of variables of DC machines with block diagrams
4. To understand the concept of reference frame theory applicable to machines
5. To understand the concept of voltage equations with respect to synchronous machines.

Course Title : Flexible Ac Transmission Systems (Facts)			
Course Code : P13EE833	**Semester : VIII**	**L - T - P : 2- 2 - 0 -4**	**Credits: 3**
Contact Period: Lecture: 50 Hr, Exam: 3 Hr	**Weight age: CIE:50%; SEE:50%**		

Prerequisites: The student should have undergone the course on Power Electronics.

Course Learning Objectives

1. Concepts and general system configuration.(L1)
2. Basic concepts of Single-phase full-wave bridge converter operation.(L3)
3. Basic concepts, 3-phase full wave diode rectifier.(L3)
4. Static Shunt Compensator: SVC,STATCOM.(L4)
5. Static Series Compensators: GCSC,TSSC,TCSC and SSSC.(L4)

Relevance of the Course:

The students will examine the basic information and techniques underlying with FACTS Controllers. The course deeply provides an understating in Comparison of normal transmission with respect to FACTS Controllers. The course intended to introduce analysis of Static shunt and series compensator. The control strategies involved will help the students to interpret about the control over the power, voltage & current characteristics in FACTS devices. The students will able to understand about the troubles caused faults & harmonics which are involved in FACTS transmission and protection against the same.

COURSE CONTENT

Unit – I

FACTS: Concepts and general system configuration. Transmission, interconnection, flow of power in AC system, power flow and dynamic stability consideration, of a transmission interconnection, relative importance of controllable parameters, basic types of FACTs controllers, shunt, series, combined shunt and series connected controllers. **10Hrs**

Unit – II

Voltage sourced converters: Basic concepts, single phase full wave bridge converter operation, square wave voltage harmonics for a single phase bridge 3 phase full wave bridge converter. Self and line commutated current source converter. **10Hrs**

Unit – III

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

Unit – IV

Static shunt compensator: SVC and STATCOM: objective of shunt compensation, methods of controllable Var generation, static Var compensator, SVC and STATCOM, comparison between, SVC and STATCOM. **10Hrs**

Unit – V

Static series compensators: GCSC, TSSC, TCSC and SSSC, objectives of series compensation; variable impedance type of series compensation, switching converter type series compensation, external control for series reactive compensators. **10Hrs**

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, 1st Edition, 2001, ISBN 81-86308-79-2.

Reference Books:

1.R.Mohan Mathur, Static Controllers for Electrical Transmission Systems, IEEE Press and John Wiley & Sons, Inc.,

2.R.Mohan Mathur and Rajiv K. Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, IEEE Press and John Wiley & Sons, Inc.

Course Outcomes

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

CO1. Describe the types of FACTS controllers; Shunt, Series, Combined shunt and series connected controllers.

CO2. Analysis of single phase leg operation, square wave voltage harmonics for a single phase bridge, converter operation.

CO3. To study the operation of Thyristor Based converter (with Gate Turn on but without Gate Turn off).

CO4. Objectives of shunt compensation, Methods of controllable Var Generation Comparison between SVC and STATCOM.

CO5. To study about the GCSC, TSSC, TCSC and SSSC, switching converter type series compensation

Model Question Paper

	UNIT - I	Marks	Blooms level	COs
1. a.	Explain the basic types of FACTS controller along with its symbolic notations.	10	L2	CO1
b.	With relative diagrams, explain the AC power flow in parallel paths.	10	L1	CO1
2 a.	Explain Power flow and dynamic stability consideration of transmission interconnection.	10	L2	CO1
b.	Explain the operation of shunt connected controller.	10	L2	CO1
UNIT - II				
3 a.	Derive the expression for the fundamental and harmonics of square wave output voltage of a single phase bridge converter. Prove that the RMS value of the fundamental component V1=0.9Vd.	10	L3	CO2
b.	Explain the operation of three-phase full wave voltage sourced converter, with relevant circuit diagram and waveforms.	10	L2	CO2
4 a.	Explain the single phase full wave bridge voltage sourced converter operation	10	L2	CO2
b.	Discuss the basic principles of voltage sourced converters and its concept with the help of relevant circuits.	10	L4	CO2
UNIT - III				
5 a.	With the help of neat sketches, explain the three principal types of current sourced converters	10	L1	CO3
b.	Discuss three phase, full wave six pulse diode converter in detail neglecting commutation angle, showing relevant current and voltage waveforms.	10	L4	CO3
6. a	Explain current stiff converters with relevant circuit diagram and waveform.	10	L2	CO3
b.	Compare current sourced converter versus voltage sourced converter.	10	L2	CO3
UNIT - IV				
7 a.	Explain the 6 pulse and 12 pulse current sourced converter operations with neat waveform in AC Current Harmonics.	10	L2	CO4
b.	Explain Thyristor based converter Rectifier operation.	10	L2	CO4
8 a.	Explain the operation of End of the line voltage support to prevent voltage instability in static shunt compensators.	10	L2	CO4
b.	Explain with waveform of Power oscillation damping in static shunt compensators.	10	L2	CO4
UNIT - V				
9 a.	With the help of basic circuit arrangement, explain the operation of Thyristors Controlled Series Capacitor. (T.C.S.C).	10	L1	CO5
b.	Discuss in detail GCSC with the help of Basic GTO controlled series capacitor circuit.	10	L4	CO5
10 a.	With the help of block diagram, explain the functional system (external) control scheme for the SSSC	10	L1	CO5
b.	Explain STATIC VAR COMPENSATORS, SVC and STATCOM with respect to V – I and V- Q characteristics and loss versus VAR output characteristics.	10	L2	CO5

Course Title: Discrete - Time Control Systems			
Course Code: P13EE834	**Semester: VIII**	**L-T-P-H: 2-2-0-4**	**Credits - 3**
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		**Weightage : CIE:50%; SEE:50**	

Course Objectives:

1. To introduce analysis of sampled data control systems using Z-transform
2. To design of Discrete time control systems and to educate students about the Stability of Discrete time control systems.
3. To educate students about the benefits and necessity of State Space Design of Discrete time control systems.
4. To make students familiar with the Lipunov Stability analysis of Linear Time Invariant Continuous and Discrete Time Systems.
5. To design of Discrete time control systems using Pole Placement And Observer

Course content

UNIT-I

Analysis of discrete-time control systems:
Introduction, Sampling process, Analysis of sampling process in frequency domain, Reconstruction of sampled signals using hold circuits, Discrete sequence(Discrete time signal). Z-transform, Linear discrete time systems, Transfer function of LDS system(Pulse transfer function),Analysis of sampler and zero- order hold, Analysis of systems with impulse sampling, Analysis of sampled data control systems using Z-transform. **12 Hrs**

UNIT-II

Design of Discrete time control systems:
The Z and S- domain relationship, Mapping between the S-plane and the Z-plane, Stability analysis of closed loop systems in the Z-plane, Transient and Steady state response analysis. **10 Hrs**

UNIT-III

State Space Analysis: State space representation of Discrete time systems, Solution of discrete time state space equations, Pulse transfer functions matrix, Discretization of continuous time state space equations. **10 Hrs**

UNIT-IV

Liapunov stability analysis: Definiteness of Scalar functions,Lipunov functions, Stability in the sense of Lipunov, Asymptotic Stability, Asymptotic Stability in the large, Instability, Lipunov Stability analysis of Linear Time Invariant Continuous and Discrete Time Systems, **10 Hrs**

UNIT-V

Pole Placement And Observer Design: Controllability and Observability of Discrete time systems, complete state controllability in the z- plane, principle of duality, effects of the Discretization of a Continuous-time control system on Controllability and Observability, complete useful transformations in state space analysis and design, design via poleplacement, state observers.
10 Hrs

Text Books:
1. **"Discrete-Time Control Systems"**-Katsuhiko Ogata, 2nd Edition, Pearson Education, 2005.
2. **"Advanced Control Theory"- A.NagoorKani, 2nd** Edition, RBA Publication.
Reference Books:
1.Digital Control and State Variable Methods,M. Gopal, 2nd Edition, TMH, 2007.
2. Modern Control System, Richard C. Dorf, Robert H. Bishop, Pearson,11th Edition

Course Outcomes:

At the end of the course Students are able to
1. Analyze the stability and performance of discrete time control systems to ensure that the system meets the desired specifications.
2. To know about the Lipunov Stability analysis of Linear Time Invariant Continuous and Discrete Time Systems.
3. To familiarize about discrete time control systems using Pole Placement and Observer.

Course Title: Computer Control of Electric Drives			
Course Code: P13EE841	Semester: VIII	L-T-P-H: 2-2-0-4	Credits - 3
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		Weightage : CIE:50%; SEE:50%	

Course learning objective (CLOs):

1. Understand and analyze different types of microcontrollers & sensors applications.
2. Understand and explain the basics and methods of speed control of induction motors.
3. Understand and explain the basics of synchronous machines & the control techniques of phase controlled converters.
4. Understand and explain the slip power Recovery schemes for induction motors control.
5. Understand and analyze the basics of Vector control techniques for ac drives.

Course Content

UNIT-I

Review of Microcontrollers in industrial drives system. Typical Microcontrollers, 8 bit/16 bit/32 bit (only block diagram), Digital Data Acquisition System, voltage sensors, current sensors, frequency sensors and speed sensors, Block diagram for power integrated circuit for DC motor drives. **10Hrs**

UNIT-II

Induction Motor Drives: General classification and National Electrical manufacturer Association (NEMA) classification, Speed control of induction motors with Variable voltage, constant frequency, constant voltage variable frequency,(V/f) Constant operation, drive operating regions. Variable stator current operation**.** **10Hrs**

Unit-III

Synchronous Machine drives: wound field machine, comparison of induction and wound field synchronous machines and torque angle characteristics of salient Pole synchronous machine.

Phase controlled converters :converter controls, linear firing angle control, Cosine wave crossing control, Phase- locked oscillator principle, cyclo-converters, voltage fed converters, PWM Rectifiers and current fed converters**.** **12Hrs**

Unit-IV

Principle of slip power Recovery schemes Static Kramer Drive system, block schematic diagram and phasor diagram and Limitations, static Scherbius scheme system using DC link converters with Cyclo converter modes of operation; Modified Scherbius drives for variable Source Constant Frequency (VSCF) generation. **10Hrs**

Unit-V

Principle of Vector control of AC drives :Phasor diagram, digital implementation block diagram, flux vector-estimation, Indirect vector control block diagram with open loop flux control, synchronous Motor control with compensation. **10Hrs**

Text Books:-

1. Modern Power Electronics & Drives, BimalK.Bose, Pearson Education,4th edition, 2003.

Reference Books:

2. Power Electronics and motor drives,BimalK.Bose, Elsevier, 2006.

3Fundamentals of Microprocessors and applications, BadriRam ,Pearson, 2001.

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Course outcomes(COs):

1. To analyze and select the different types of microcontrollers & use of sensors and applications of them.
2. To analyze and implement the various speed control methods for induction motors.
3. To analyze the basics of synchronous machine & implement the control techniques of phase controlled converter
4. To understand and implement the slip power recovery schemes for the control of induction motors
5. To analyze and implement the Vector control techniques for ac drives

Course Title: Insulation Engineering			
Course Code:	Semester:	L-T-P-H: 2-2-0-4	Credits - 3
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		Weightage : CIE:50%;	

Course learning objective (CLOs):

1. Understand and analyze different types of insulation & dielectric phenomena.
2. Understand and explain the properties of insulating materials in different media.
3. Understand the concept of gaseous insulation and breakdown phenomenon
4. Understand the concept of ageing mechanisms of insulating materials.
5. Understand the concept of failure of insulation.

Course content

UNIT-I

Insulation system in power apparatus: Insulation system in capacitors, bushings, transformers, Modes of failure of insulation systems. Insulation in rotating machines.
Dielectric phenomena: Dielectric phenomena in solid insulation. Macroscopic approach for describing the dielectric phenomena: Microscopic treatment for dielectric phenomena. **11Hrs**

UNIT-II

Properties of insulation materials: Introduction to properties of solid insulating materials (both of natural origin and synthetic types). Properties of liquid insulating materials, Review of breakdown phenomena in solid and liquid insulating media. **10 Hrs**

UNIT-III

Gaseous insulation: Requirement of gaseous insulation. Breakdown processes: Types of collision, Elastic and inelastic collisions, Collision cross-section, Mobility of ions, Diffusion of charges, Emission of radiation and excitation, various secondary processes and recombination, Mobility controlled and Diffusion controlled breakdown. **11Hrs**

UNIT-IV

Ageing phenomena: Failure of electrical insulation due to ageing. Ageing mechanisms-Thermal ageing, Electrical ageing, combined thermal and electrical ageing. **10Hrs**

UNIT-V

Analysis of insulation failure data: Power law model, Graphical estimation of power law constants, procedure, ageing data, plotting position and cumulative failure probability. **10 Hrs**

Text Book:

1. Reliability and Life Estimation of Power Equipment, T. S. Ramu and Chakradhar Reddy, , New Age International, 1st Edition ,2009.

Reference Books:

2. Electrical insulation ,Bradwell A., , Peter peregrinus Ltd., London, 1983.
3. Fundamentals of gaseous ionization and plasma electronics ,Nasser E, John Wiley interscience, New York, 1971.
4. Methods of statistical analysis and life data , Hann N. R., Schafer R. E. and Singaporewalla N. D John Wiley and sons, New York, 1974.
5. High Voltage Engineering, M. S. Naidu and V. Kamaraju, Tata McGraw Hill, 3rd edition ,1995.

Course outcomes(COs):

1. To analyse the different types of insulating materials& dielectric phenomena
2. To understand about the properties of insulating materials in solid and liquid media.
3. To understand the concept of gaseous insulation and breakdown processes.
4. To understand the concept of ageing mechanisms of insulating materials.
5. To analyse the concept of failure of insulation

Course Title: HVDC Power Transmission			
Course Code: P13EE843	Semester: VIII	L-T-P-H: 2-2-0-4	Credits - 3
Contact period : Lecture: 50 Hrs, Exam 3 Hrs		Weightage : CIE:50%; SEE:50%	

Prerequisites: The student should have undergone the course on HVDC Power Transmission

Course Learning Objectives

1. Comparison of DC transmission with respect to AC transmission (L2,L5)
2. Analysis of converters – assumptions, characteristics & Properties (L4)
3. Analysis of Gratez circuit (rectification & inversion) (L4,L1)
4. To study the control strategies involved in DC Transmission (L3,L4)
5. To know about the role of protection, harmonics & filters in DC transmission (L2,L4)

Relevance of the Course:

The students will examine the basic information and techniques underlying with HVDC Power Transmission. The course deeply provides an understating in Comparison of DC transmission with respect to AC transmission. The course intended to introduce analysis of Gratez circuit without overlap & with overlap (<60°) (rectification & inversion) which helps students to understand conversion & inversion technique in detail. The control strategies involved will help the students to interpret about the control over the power, voltage & current characteristics in DC transmission. The students will able to understand about the troubles caused faults & harmonics which are involved in DC transmission and protection against the same.

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, Applications of DC transmission, Description of DC transmission systems. **10Hrs**

Unit –I

Converter circuits: Valve characteristics, Properties of converter circuits, assumptions, single phase and three phase converters **10Hrs**

Unit -III

Analysis of bridge converter: Analysis with grid control without overlap, Analysis with grid control and overlap less than 60Ú. Complete characteristics of rectifier, Inversion **10Hrs**

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, Tap changer control, Power control and current limits, MTDC systems. **10Hrs**

Unit –V

Protection: General, DC reactors, 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**

Text Book:

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

Reference Books:

1. Direct Current Transmission, E. W. Kimbark, - Volume I, Wiley futerscience, 1971.
2. HVDC Power transmission systems - Technology and System Interactions, K. R. Padiyar, Wiley Eastern Limited, 1992.

Course Outcomes

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

1. Comparison of DC transmission with respect to AC transmission, Historical sketch, DC links, recent trends & Applications of DC transmission
2. Discussion on valve characteristics, Properties and analysis of converters
3. Analysis of Gratez circuit without overlap & with overlap (<60°) (rectification & inversion)
4. To interpret the control strategies in reversal, manual control, Actual control characteristics, Stability & MTDC systems.
5. To study about the converter faults and its protection, Characteristic / Uncharacteristic harmonics, their Troubles & filters.

Model Question Paper

		Marks	COs	Levels
1. a.	Compare AC and DC transmission based on their relative, technical performance and reliability.	10	CO1	L4
b.	Mention the principle applications and limitations of DC transmission.	6	CO1	L2
c.	Explain the various types of DC links along with their schematic connections diagrams.	4	CO1	L2
	or			
2. a.	State any three HVDC projects in India and mention their technical specifications.	6	CO1	L1
b.	Bring out the comparison between AC and DC transmission systems on the economics of power transmission front. Explain the significance of ‘Breakeven distance’ in this context.	6	CO1	L4
c.	Discuss the choice of optimum system voltage for a fixed power transfer over long distance transmission lines.	8	CO1	L6
3.a.	Discuss the turn- on and turn – off switching characteristics of thyristor.	10	CO2	L5
b.	Discuss the properties of converter circuits.	5	CO2	L6
c.	Define pulse number and comment on choice of best converter configuration.	5	CO2	L1
	or			
4.a.	With neat circuit diagram, explain three phase one way rectifier and derive an expression for V_d	10	CO2	L2
b.	Explain the characteristics of a twelve pulse converter	10	CO2	L2
5.a.	Perform the analysis of Gratez circuit with overlap less than 60 degrees. Obtain the expression for average direct voltage in each case.	10	CO3	L3
b.	A bridge connected rectifier is fed from 220 kV / 110 kV transformer with primary connected to 220 kV. Determine the DC output voltage when the communtation angle is 15º and delay angle is 30º.	10	CO3	L5
	or			
6. a.	A Graetz circuit operating at 50 Hz has a line to line voltage of 440V. Considering AC line inductance ‘Lc’ = 1 Henry, alpha = 15 and u = 10. Compute: i) Average current and voltage ii) Equivalent Communication resistance.Also draw the equivalent circuit of the bridge converter	12	CO3	L1
b.	Perform the analysis of Gratez circuit without overlap. Obtain the expression for average direct voltage.	8	CO3	L3
7. a.	Explain the basic principles of controlling the voltage at any point on the DC line and the current. Mention the considerations influencing the selection of control characteristics.	10	CO4	L2
b.	Discuss the actual characteristics of converter control. In this context, explain the significance of current margin and its range.	10	CO4	L5
	or			
8. a.	Mention the limitations of manual control.	5	CO4	L1
b.	What are MTDC systems? Explain the two configurations of MTDC systems.	5	CO4	L1
c.	What is mode ambiguity and in this context explain the modification of V-I characteristic for mode stabilization.	10	CO4	L1
9. a.	Explain the basic types of faults that can occur in converters	10	CO5	L2
b.	Discuss the procedure for clearing the line faults and re-energizing the line.	10	CO5	L6
	or			
10. a.	Explain the phenomenon of ‘Telephone interference’ and the factors affecting it in detail.	10	CO5	L2
b.	Define Characteristic and Non-characteristic harmonics. Explain the troubles caused by harmonics and functioning of harmonics filters.	10	CO5	L1

Course Title: Renewable Energy Sources			
Course Code: P13EE844	Semester: VIII	L-T-P-H: 2-2-0-4	Credits - 3
Contact period : Lecture: 50 Hrs, 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-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; comparison of conventional and non-conventional energy resources; world energy scenario; Indian energy Scenario. **06 Hrs**

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 tidal surface(Numerical Problems) Measurement of Solar Radiation data-pyranometer & pyrheliometer. **04 Hrs.**

UNIT-2

Solar Thermal System: Principle of conversion of solar radiation into heat, solar water heater(Flat plat collectors)solar cookers-boxtype, concentrating dish type, solar driers, 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. **10 Hrs.**

UNIT-3

Wind Energy: Introduction, wind & its property, 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

UNIT-4

Biomass Energy: Introduction photosynthesis process , 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.**

UNIT-5

Energy From Ocean: Tidal energy-principle of tidal power, 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 ofTTP. 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 of OTEC). **10 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: Need for knowing importance of the electrical energy the various factors contributing for the demand and supply of electrical energy.

CO2: Conversion principles, potential of the solar energy, various types of solar energy working with solar energy.

CO3: Scenario of the wind energy. Wind energy conversion systems different types of assemblies, applications.

CO4: Photosynthesis process, biomass conversion technologies. Solid waste conversion and management systems.

CO5: Basic energy conversion principle of tidal and ocean energy. Different types of tidal power plant, ocean thermal energy conversion systems, applications.