Syllabus

(With effect from 2015-2016 Academic year)

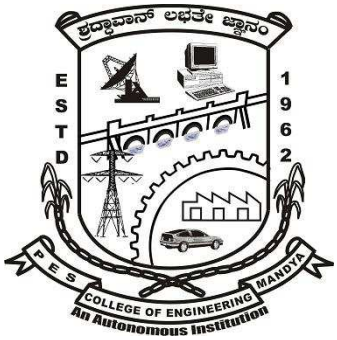
ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2015–16)

V & VI Semester

Bachelor Degree
in
Electrical & Electronics Engineering

Out Come Based Education
with
Choice Based Credit System



P.E.S. College of Engineering, Mandya - 571 401, Karnataka

(An Autonomous Institution Affiliated to VTU, Belagavi)

Grant -in- Aid Institution

(Government of Karnataka)

Accredited by NBA, New Delhi

Approved by AICTE, New Delhi.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ

(ವಿ.ಟಿ.ಯು., ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

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Preface

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

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

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

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

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

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

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

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

Sri. B.Dinesh Prabhu
Deputy Dean (Academic)
Associate Professor,
Dept. of Automobile Engg

Dr.P S Puttaswamy
Dean (Academic)
Professor,
Dept. of Electrical & Electronics Engg.

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Vision

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

Mission

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

Program Educational Objectives (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

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 Engineeringproblems.

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

P.E.S COLLEGE OF ENGINEERING, MANDYA
(An Autonomous Institution under VTU, Belgaum)

Scheme of Teaching and Examination **V Semester B.E Electrical & Electronics Engineering**

Sl. No.	Course Code	Course Title	Teaching Dept.	Hours/ Week L:T:P	Credits	Examination Marks		
						CIE	SEE	Total
1.	P15EE51	Power Electronics	E & E E	4:0:0:4	4	50	50	100
2.	P15EE52	Linear Control Systems	E & E E	3:2:0:5	4	50	50	100
3.	P15EE53	Electrical Machines-II	E & E E	4:0:0:4	4	50	50	100
4.	P15EE54	Foundation Course-I Transmission & Distribution	E & E E	4:0:0:4	4	50	50	100
5.	P15EE55	Foundation Elective-I	E & E E	2:2:0:4	3	50	50	100
6.	P15EE56	Elective-I	E & E E	2:2:0:4	3	50	50	100
7.	P15EEL57	Power Electronics Lab	E & E E	0:0:3:3	1.5	50	50	100
8.	P15EEL58	Electrical Machines Lab - II	E & E E	0:0:3:3	1.5	50	50	100
9.	P15EE59	Industry Visit & Interaction	E & E E	0:0:2:2	1	50	--	50
10.	P15HU510	Aptitude and Reasoning Development –Advanced. (ARDA)	HS&M	2:0:0:2	1	50	50	100
Total					27	500	450	950

List of Electives

Foundation Elective			Elective - 1		
Sl. No	**Course Code**	**Course title**	**Sl. No.**	**Course Code**	**Course title**
1.	P15EE551	Operational Amplifiers & Linear Integrated Circuits	1.	P15EE561	Utilization of Electrical Power
2.	P15EE552	Fuzzy Logic	2.	P15EE562	Software Engineering
3.	P15EE553	Operation Research	3.	P15EE563	Electrical Material Science
4.	P15EE554	Management & Entrepreneurship	4.	P15EE564	Micro Electromechanical System

Scheme of Teaching and Examination **VI Semester B.E Electrical & Electronics Engineering**

Sl.No	Course Code	Course Title	Teaching Dept.	Hours/ Week L:T:P	Credits	Examination Marks		
						CIE	SEE	Total
1.	P15EE61	Power System Analysis and Stability	E & E E	4:0:0:4	4	50	50	100
2.	P15EE62	Digital Signal Processing	E & E E	3:2:0:5	4	50	50	100
3.	P15EE63	Electrical Machine Design	E & E E	3:2:0:5	4	50	50	100
4.	P15EE64	Foundation Course-II Switchgear & Protection	E & E E	4:0:0:4	4	50	50	100
5.	P15EE65	Elective-II	E & E E	2:2:0:4	3	50	50	100
6.	P15EE66	Elective-III	E & E E	2:2:0:4	3	50	50	100
7.	P15EEL67	Control System & DSP Lab	E & E E	0:0:3:3	1.5	50	50	100
8.	P15EEL68	Electrical Auto CAD Lab	E & E E	0:0:3:3	1.5	50	50	100
9.	P15EE69	Mini Project	E & E E	0:0:2:2	1	50	--	50
10.	P15HU610	Aptitude and Reasoning Development – EXPERT (ARDE)	HS&M	2:0:0:2	1	50	50	100
Total					27	500	450	950

List of Electives

Elective-II			Elective - III		
Sl. No	**Course Code**	**Course title**	**Sl. No.**	**Course Code**	**Course title**
1.	P15EE651	Modern Control Theory	1.	P15EE661	Programmable Logic Controller & SCADA
2.	P15EE652	Advanced Power Electronics	2.	P15EE662	Illumination Engineering
3.	P15EE653	Embedded Systems	3.	P15EE663	Design of Control System
4.	P15EE654	Operating System	4.	P15EE664	Switched Mode Power Supply

V SEMESTER

Course Title: Power Electronics			
Course Code:P15EE51	**Semester: V**	**L-T-P-H(Hrs): 4-0-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims is to:

1. To get overview of various types of power semiconductor devices, their control and switching characteristics.
2. To understand the principle of operation, characteristics and performance parameters of controlled rectifiers and inverters.
3. To get overview of various types of commutations and understand the various types of controllers.
4. To study the operation and basic topologies of Ac-dc converters, Dc-Ac inverters, Dc-Dc Choppers and Ac-Ac voltage controllers.
5. Developing the students with mathematical, scientific and computational skills to design, analyze and solve problems related to various types of power converter systems.

Course Content

Unit – I

Power Semiconductor Devices: Introduction, Applications of Power Electronics, Power semiconductor devices, Control characteristics, Types of power electronics circuits, Peripheral effects.

Power Transistors: Introduction, Power bipolar junction transistors, Power MOSFETs, IGBTs and their Switching characteristics. **10hrs**

Unit – II

Power Transistors: Base-drive control, Gate drive, di/dt and dv/dt limitations, Isolation of gate and base drives

Thyristors: Introduction, Construction and Static V-I characteristics ; Two transistor model of thyristor, Turn-on and Turn-off, di/dt and dv/dt protection, Thyristor types, Series and parallel operation of thyristors, Thyristor firing circuits. **10hrs**

Unit – III

Thyristor Commutation Techniques: Introduction, Commutation - natural, forced, self, impulse, resonant pulse & complementary

AC Voltage Controllers: Introduction, Principle of ON-OFF control, Principle of phase control - single phase and bi-directional controller with resistive load and Inductive load. Tree Phase half wave and Full wave AC Voltage Controllers. **10hrs**

Unit – IV

DC Choppers: Introduction, Principle of step-down and step-up choppers, Step-down chopper with RL load and their analysis, Chopper classifications and their operations.

Inverters: Introduction, Principle of operation, Performance parameters, Single phase half & full bridge inverters, Analysis of single phase inverters, voltage control of single phase inverters, 3phase voltage source inverters. **10hrs**

Unit –V

Controlled Rectifiers: Introduction, Principle and operation of single phase controlled converter - half wave, Semi-converter, full wave, dual converter; 3 phase half wave & full wave converters.(excluding problems on three phase -converters). **10hrs**

TEXT BOOKS:-

1. Rashid, Power Electronics , Prentice Hall India Pvt Ltd, 4th edition,2014.
2. P S Bhimbra, ”Power Electronics”, Khanna publishers,3rd edition,1999

REFERENCE BOOKS:-

1. G.K. Dubey, etal “Thyristorised Power Controllers”, Wiley Eastern edition,4th edition.-
2. M.D. Singh &Kanchandoni,”Power Electronics”, TMH Publishers Company, reprint 2014.

Course Outcomes

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

CO1: Select various types of power semiconductor devices to develop different types of Power converter systems based on control characteristics.

CO2: Analyze the different base drive control methodologies and various types of Protection Circuits needed for converter system.

CO3: Distinguish between various types of power converter systems, compare and analyze them.

CO4: Understand and analyze the various types of commutation circuits and implement them.

CO5: Design and develop different types of converter and inverter system.

Topic Learning Objectives

After learning all the topics of unit-I, the student is able to:

1. Understand the basic concepts Power Electronics converter systems
2. Explain the operation of different types of power converter systems
3. Explain the control characteristics of semiconductor devices and peripheral effects
4. Explain the basic concepts of Bipolar transistor and their characteristics

After learning all the topics of unit-II, the student is able to:

1. Explain the need of base drive control and their control techniques
2. Explain the constructions and working of a MOSFET, IGBT & Thyristor.
3. Explain the switching characteristics of a MOSFET, IGBT & Thyristor
4. Explain the various types of Gate drive and protection circuits
5. Explain the various types of Isolation circuits
6. Use of series & parallel operation of thyristor and their firing circuits

After learning all the topics of unit-III, the student is able to:

1. Explain the need of commutation and different methods of commutation circuits
2. Analyze natural, forced and load commutation circuits
3. Understand the basic principle of Ac voltage controllers
4. Analyze the Ac voltage controller operation with various loads
5. Compare and select the different types commutation circuits
6. Compare and select the different types of Ac voltage controller circuits

After learning all the topics of unit-IV, the student is able to:

1. Describe the basic principle of chopper configurations
2. Analyze and distinguish among various choppers configuration
3. Describe the basic principle of Inverter configurations
4. Analyze and distinguish among various inverter configurations
5. Compare and select the different types of chopper configuration
6. Compare and select the different types of inverter configuration

After learning all the topics of unit-V, the student is able to:

1. Describe the basic principle of converter configurations
2. Analyze and distinguish the various converter configurations
3. Analyze and understand the idea of generating gating pattern for converter system Compare and select the different types of converter system

Review Questions

1. What do you mean by power Electronics?
2. With the help of block diagram explain the power converter system.
3. Mention the peripheral effects of Power converter system & what are their remedies?
4. With reference to control characteristics what is the difference between a Thyristor & GTO.
5. With reference to control characteristics what is the difference between a MOSFET & BJT.
6. With relevant circuit & waveform explain Ac-Dc conversion.
7. With relevant circuit & waveform explain Dc-Ac conversion.

8. Draw the circuit symbol their V-I characteristics of two semi conductor devices.
9. What are the advantages of Power Semiconductor devices?
10. Mention the Ideal characteristics of a semiconductor device.
11. Why the transistor is called as Bi polar device?
12. Explain the switching characteristics of a BJT.
13. What is the need of Base drive control?
14. Explain anti saturation control.
15. What is a need of Isolation circuits?
16. What is a need of protection circuits for semiconductor devices?
17. What is a Thyristor? Explain the construction details
18. Explain the static V-I characteristics of a Thyristor.
19. Why high dv/dt should able to trigger thyristor into conduction?
20. Why is pulse triggering is preferred for thyristors?
21. Name the various causes of over voltages in thyristors.
22. Why special heat sinks are are necessary for thyristors?
23. Why does the thyristors required to be connected in series?
24. What is the difference between converter grade & inverter grade thyristors?
25. What do you mean by commutations?
26. What are the conditions to be satisfied to turn-off a thyristor
27. Which current among latching current and holding current is larger?
28. What is a need of two transistor analogy of a thyristor?
29. What is the need of understanding various voltage and current ratings?
30. What do you mean by natural commutation?
31. What do you mean by complementary commutation?
32. What is the difference between auxiliary and main device?
33. What do you mean by an Ac voltage controller?
34. What is the difference between Ac voltage controller and Inverter?
35. Why short duration pulses are not sufficient for an Ac voltage controller for an RL load?
36. Distinguish between half & full wave Ac voltage control.
37. What are the two methods of control of an Ac voltage controller?
38. What is a Chopper?
39. Mention the applications of choppers.
40. What are the methods of duty cycle control in choppers?
41. Distinguish between step-up and step-down chopper.
42. What is the basis on which the choppers are classified?
43. What is an Inverter? What are their applications?
44. Distinguish between half & full bridge inverters.
45. Mention the methods of Voltage control in inverters.
46. What are the two possible modes of operation of 3-ph inverter?
47. What are the applications of controlled rectifiers?
48. Classify the different types of controlled rectifiers.
49. What is the effect of connecting a freewheeling diode in an half wave rectifier?
50. How in full bridge converter the role of converter and inverter can be interchanged.

Lesson Plan

Unit- I

1. Introduction to power electronics and their applications.
2. Description of Various types of semiconductor devices, their V-I chars, symbols and their applications.
3. Explanation of various types of power converter systems.
4. Power semiconductor devices and control chars

5. Power converter systems explanation, peripheral effects and their remedies.
6. Introduction to power transistors, types of power transistors, construction and their applications.
7. Principle of operation of BJTs with input and output chars.
8. Switching chars of MOSFET.
9. Switching chars of IGBT and comparison between MOSFET and IGBT.
10. Problems

Unit-II

1. Description of various types of base drive control circuits, merits and demerits of each.
2. Description of various limits and their protection circuits.
3. Description of Isolation circuits
4. Introduction to thyristors and their families with the applications.
5. Constructional features of thyristors and its principle of operations.
6. Static chars of thyristors.
7. Two transistor model of thyristors.
8. Turn on and turn-off chars of thyristors
9. Series and parallel operations of thyristors.
10. Thyristor firing circuits and problems.

Unit- III

1. Introduction to commutation and their requirement. Classification of commutation circuits.
2. Types of commutation circuits-natural commutation and self-commutation.
3. Types of commutation circuits-Impulse and resonant commutation.
4. Types of commutation circuits- Complementary commutation and problems.
5. Problems
6. Introduction to AC voltage controller, types and applications.
7. Principle of on/off control and problems.
8. Principle of phase control with resistive load.
9. Principle of phase control with inductive load.
10. Problems.

Unit- IV

1. Introduction to choppers, classification and applications.
2. Types of choppers A, B, C, D
3. Four quadrant chopper operation.
4. Principle of Step-down and step-up chopper configurations.
5. Problems.
6. Introduction to inverters, classification and their applications. Description of Performance parameters of inverters.
7. Various types of inverters with R and RL load
8. Three phase bridge inverters.120 degree mode
9. Three phase bridge inverters: 180 degree Mode
10. Problems.

Unit- V

1. Introduction to rectifiers, classification and their applications
2. Principle of operation of half wave converter with R load.
3. Principle of operation of half wave converter with RL load and with freewheeling diode.
4. Half controlled converter operation.
5. Full controlled converter operation.
6. Dual converter operation.
7. Problems.
8. Problems.
9. Three phase half wave converter operation
10. Three phase full wave converter operation.

Course Articulation Matrix (CAM)

Course Outcome – CO			Program Outcome (ABET/NBA-(3a-k))											
			1	2	3	4	5	6	7	8	9	10	11	12
1	To get overview of various types of power semiconductor devices, their control and switching characteristics.	**L1**	L	M	H	_	L	_	_	_		_	-	L
2	To understand the principle of operation, characteristics and performance parameters of controlled rectifiers and inverters.	**L2**	M	L	H	_	L		_	_	_	_	_	M
3	To study the operation and basic topologies of dc-dc switching regulators, inverters dc-ac and Ac-ac voltage controllers.	**L3**	M	M	H	_	L	_	_	_		_	_	M
4	Developing the students with mathematical, scientific and computational skills to analyze and solve problems related to various power converter systems.	**L4**	H	M	H	_	H	_	_	_		_	_	H
	L-Low, M-Moderate, H-High													

Course Assessment Matrix(CAM)

Course Outcome - CO			Program Outcome (ABET/NBA-(3a-k))											
			1	2	3	4	5	6	7	8	9	10	11	12
1	To get overview of various types of power semiconductor devices, their control and switching characteristics.	**L1**	1	2	3	_	1	_	_	_		_	-	1
2	To understand the principle of operation, characteristics and performance parameters of controlled rectifiers and inverters.	**L2**	2	1	3	_	1		_	_	_	_	_	2
3	To study the operation and basic topologies of dc-dc switching regulators, inverters dc-ac and Ac-ac voltage controllers.	**L3**	2	2	3	_	1	_	_	_		_	_	2
4	Developing the students with mathematical, scientific and computational skills to analyze and solve problems related to various power converter systems.	**L4**	3	2	3	_	3	_	_	_		_	_	3
	1-Low, 2-Moderate, 3-High													

Course Title: Linear Control Systems			
Course Code:P15EE52	**Semester: V**	**L-T-P-H(Hrs): 3-1-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to:

1. Derive the transfer function and mathematical model for a variety of electrical, mechanical and electromechanical systems.
2. Find the time domain specifications and time response for a given system for various inputs.
3. Analyze the performance and stability of a given system through root locus, Polar plots, Nyquist plots and Bode plots.

Course Content

Unit – I

Fundamental Concepts of Control Systems: Basic definitions of control systems, Classification, Open loop and Closed loop systems, types of feedback, effects of feedback on overall gain, stability, sensitivity and external disturbance or noise, Servomechanism.

Modeling of Systems: Differential equations of physical systems, Determinations of transfer function models for Electrical, Mechanical, Electromechanical systems and Analogous systems.

Block diagrams and Signal flow graphs: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded). **10hrs**

Unit – II

Transient and Steady State Response Analyses of Feedback Control Systems: Standard test signals, Unit step response of First and second order systems.

Time response specifications: Transient response specifications of second order systems, steady state errors and static error constants. Effect of adding poles and zeros to open loop and closed loop transfer function, concepts of dominant poles of transfer function. **10hrs**

UNIT-III

Stability analysis: Concepts of stability, Asymptotic stability, impulse response stability, BIBO stability, necessary conditions for stability, Routh-Hurwitz stability criterion, Routh's tabulation, special cases when Routh's tabulation terminates prematurely.

Root–Locus Techniques: The root locus concepts, summary of general rules for constructing Root Loci, Stability analysis, determination of transient performance specifications and the value of K for specified ξ , gain margin, Effects of adding poles and zeros to the product of G(S)H(S) on shape of the Root locus, Root contour. **10hrs**

Unit – IV

Frequency-Response Analysis: Introduction, advantages and limitations of frequency domain methods, correlation between time response and frequency response, frequency response specifications- resonant peak, resonant frequency and bandwidth.

Graphical Analysis of Frequency –Response:

(i) Bode Plots:

Gain margin, Phase Margin and stability, determination of K for different Gain margin and Phase Margin, determination of transfer function from Bode magnitude plot, Relative stability analysis. **10hrs**

Unit –V

(ii) Polar plots:

Gain margin and Phase Margin and stability, determination of K for different Gain margin and Phase Margin, effects of addition poles and zeros to G(S) on shape of the polar plots, Relative stability analysis.

(iii) Nyquist plots:

Pole-zero configurations, concept of encirclement, analytical function and singularities, mapping theorem, Nyquist stability criteria, and determination of stability from the Nyquist plot. **10hrs**

Text Books:

1. Benjamin .C Kuo and Farid Golnaraghi "Automatic Control Systems", , 8th edition, Wiley India, 2010.
2. I.J Nagrath& M. Gopal "Control System Engineering", New Age International Pri Ltd, 5th edition 2012

Reference Books:

1. Katsuhiko Ogata, "Modern Control Engineering", PHI Learning Private Limited, 5th edition, 2011
2. Norman S. Nise "Control System Engineering", , 5th edition, ISV,Wiley India, 2010.

Course Outcomes

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

CO1: Do the linear modeling (Transfer Function) for Electrical, Mechanical & Electromechanical systems with the analogy.

CO2: Do the analysis of the second order system with the transient & steady state performance specification & its importance

CO3: Do the stability analysis of different systems with RH criterion & Root locus technique

CO4: Dothe frequency response analysis using analytical & Bode diagram

CO5: Do the relative stability analysis using Polar &Nyquist diagrams.

Topic Learning Objectives

After learning all the topics of unit-I, the student is able to

1. Define (i) System (ii) Control System
2. Explain how control systems are classified?
3. Define and differentiate open loop and closed loop system by giving suitable examples
4. Explain the effects of feedback on overall gain, stability, sensitivity and external disturbance and noise
5. Define the Transfer function of a system.
6. Explain the significance of a transfer function stating its advantages and features
7. Define and explain the following terms related to the transfer function of a system (i) Poles (ii) Zeros (iii) Characteristic equation (iv) Pole -zero plot (v) Order
8. What is transfer function modeling of Control systems?
9. Derive the transfer function modeling of (i) Electrical (ii) Mechanical (iii) Electromechanical systems.
10. Explain the derivation of analogues networks using (i) Force Voltage (ii) force Current analogy.
11. Derive the analogous electrical networks based on (i) Force Voltage (ii) force Current analogy for different mechanical systems.
12. Derive the transfer function for field control and armature controlled DC motor.
13. What is block diagram representation? Explain with suitable example.
14. Block Diagram representation for different electrical and Mechanical systems.
15. State advantages and Disadvantages of the block diagram reduction technique.
16. Explain the block diagram reduction rules.
17. Deducing the Transfer Function of a Block Diagram using Black Diagram Reduction rules.
18. Define signal flow graph.
19. Define the different terms related to signal flow graph.
20. Explain the various properties of signal flow graph representation.
21. Derive the signal flow graph for different systems?
22. Explain how to construct signal flow graph from (i) set of equations (ii) Block diagram with suitable example.
23. Derive transfer function for different signal flow graphs using Mason's gain formula.

After learning all the topics of unit-II, the student is able to

1. Define time response (transient response and steady state response) of a control system.
2. Explain the Impulse, step and ramp response of first order systems.
3. Explain how the damping ratio affects the time response of a second order system?
4. 4.Define the following systems sketching their output waveform for a unit step input: (i) under
5. damped system (ii) un damped system (iii) Over damped system (iv) critically damped system
6. With a neat sketch explain all time domain specifications?
7. Derive the expressions for maximum overshoot, peak time, settling time and rise time in
8. terms of ε, and ω_n for a second order control system.
9. Determine the time domain specifications for second order systems
10. Explain how steady state error of control system is determined
11. Derive the expression for static error coefficients for different systems
12. Explain the effect of adding poles and zeros to open loop and closed loop transfer Function
13. Explain the importance of dominant poles of transfer function

After learning all the topics of unit-III, the student is able to

1. 1.Define the following terms (i) stable system (ii) unstable system (iii) critically stable system
2. (iv)Conditionally stable system
3. Explain the concepts of asymptotic stability, impulse response stability, BIBO stability.
4. Explain the R-H Criteria.
5. Determine the stability of a system for different characteristic equation and determine the
6. Range of K for stability.
7. What is root-locus? Explain with suitable examples.
8. Explain the rules for sketching root-locus for different order systems
9. Explain how to determine the transient performance specifications and the value of K for
10. specified ξ, gain margin from the root locus
11. Explain the impact of adding poles and zeros to the product of G(s)H(s) on the shape of the
12. Root locus.
13. What is root contour?

After learning all the topics of unit-IV, the student is able to

1. What is frequency domain analysis?
2. Write a note on co-relation between time domain and frequency domain
3. Define and derive the expression for bandwidth of a second order system
4. Derive the expressions for Resonant peak M_r ,resonant frequency ω_r for the second order system in terms of ξ and ω_n.
5. Derive the frequency domain specifications for different systems.
6. What are Bode plots? State the advantages of Bode plots.
7. Explain the nature of Bode plots for (i) Poles at origin (ii) simple pole (iii) simple zero
8. Explain the concept of gain margin and phase margin. Explain how these values help in studying relative stability
9. Determine the value of K for different Gain margin and Phase Margin.
10. Derive the transfer function from the Bode magnitude plot.
11. Explain how the type of a system determines the nature of polar plots

After learning all the topics of unit-V, the student is able to

1. Explain how phase and gain margin are calculated from Polar plot.
2. Explain how to determine the value of K for different Gain margin and Phase Margin.
3. Explain the effects of addition poles and zeros to G(S) on shape of the polar plots.
4. Explain the concepts of Pole-zero configurations from the Nyquist point of view, concept

5. of encirclement, analytical function and singularities, mapping theorem.
6. Explain Nyquist stability criterion.
7. Draw Nyquist plots and discuss the stability of closed loop system from the given open-Loop transfer function.
8. What are the advantages of Nyquist method?

Review Questions

1. Define (i) System (ii) Control System
2. Explain how control systems are classified?
3. Define and differentiate open loop and closed loop system by giving suitable examples
4. Explain the effects of feedback on overall gain, stability, sensitivity and external disturbance and noise
5. Define the Transfer function of a system.
6. Explain the significance of a transfer function stating its advantages and features
7. Define and explain the following terms related to the transfer function of a system (i) Poles
8. (ii) Zeros (iii) Characteristic equation (iv) Pole -zero plot (v) Order
9. What is transfer function modeling of Control systems?
10. Derive the transfer function modeling of (i) Electrical (ii) Mechanical (iii) Electromechanical systems.
11. Explain the derivation of analogues networks using (i) Force Voltage (ii) force Current analogy.
12. Derive the analogous electrical networks based on (i) Force Voltage (ii) force Current analogy for different mechanical systems.
13. Derive the transfer function for field control and armature controlled DC motor.
14. Define time response (transient response and steady state response) of a control system.
15. Explain the Impulse, step and ramp response of first order systems.
16. Explain how the damping ratio affects the time response of a second order system?
17. Define the following systems sketching their output waveform for a unit step input: (i) under damped system (ii) un damped system (iii) Over damped system (iv) critically damped system
18. With a neat sketch explain all time domain specifications?
19. Derive the expressions for maximum overshoot, peak time, settling time and rise time in terms of ε, and ω_n for a second order control system.
20. Determine the time domain specifications for second order systems
21. Explain how steady state error of control system is determined
22. Derive the expression for static error coefficients for different systems
23. Explain the effect of adding poles and zeros to open loop and closed loop transfer Function
24. Explain the importance of dominant poles of transfer function
25. Define the following terms (i) stable system (ii) unstable system (iii) critically stable system (iv)Conditionally stable system
26. Explain the concepts of asymptotic stability, impulse response stability, BIBO stability.
27. Explain the R-H Criteria.
28. Determine the stability of a system for different characteristic equation and determine the range of K for stability.
29. What is root-locus? Explain with suitable examples.
30. Explain the rules for sketching root-locus for different order systems
31. Explain how to determine the transient performance specifications and the value of K for specified ξ, gain margin from the root locus
32. Explain the impact of adding poles and zeros to the product of G(s)H(s) on the shape of the Root locus.
33. What is root contour?
34. What is frequency domain analysis?
35. Write a note on co-relation between time domain and frequency domain

36. Define and derive the expression for bandwidth of a second order system
37. Derive the expressions for Resonant peak M_r ,resonant frequency ω_r for the second order system in terms of ξ and ω_n.
38. Derive the frequency domain specifications for different systems.
39. What are Bode plots? State the advantages of Bode plots.
40. Explain the nature of Bode plots for (i) Poles at origin (ii) simple pole (iii) simple zero
41. Explain the concept of gain margin and phase margin. Explain how these values help in studying relative stability
42. Determine the value of K for different Gain margin and Phase Margin.
43. Derive the transfer function from the Bode magnitude plot.
44. Explain how the type of a system determines the nature of polar plots.
45. Explain how phase and gain margin are calculated from Polar plot.
46. Explain how to determine the value of K for different Gain margin and Phase Margin.
47. Explain the effects of addition poles and zeros to G(S) on shape of the polar plots.
48. Explain the concepts of Pole-zero configurations from the Nyquist point of view, concept of encirclement, analytical function and singularities, mapping theorem.
49. Explain Nyquist stability criterion.
50. Draw Nyquist plots and discuss the stability of closed loop system from the given open-loop transfer function.
51. What are the advantages of Nyquist method?

Lesson Plan

Unit- I

1. Introduction to Control Systems and their Classification. Difference between Open Loop and Closed Loop system with suitable examples.
2. Effects of feedback on overall gain, stability, sensitivity and external disturbance and noise.
3. Introduction to Block Diagram Representation with suitable examples.
4. Block diagram representation for different Electrical, Mechanical and Electro Mechanical Systems.
5. Explain the Block Diagram Reduction rules.
6. Obtaining the Transfer Function Model of a given Block Diagram using Block Diagram Reduction rules.
7. Introduction to Signal Flow Graph and various terms and properties associated with it.
8. Explain how to construct signal flow graphs from (i) set of equations (ii) Block diagram with suitable example.
9. Problems based on derivation of Signal Flow Graphs for various system
10. How to derive the transfer function from signal flow graphs using Mason's gain formula

Unit-II

1. Introduction to Transfer Functions and its significance and advantages.
2. Explain Transfer function Modeling of Control systems and discuss the following terms related to the transfer function of a system (i) Poles (ii) Zeros (iii) Characteristic equation (iv) Pole -zero plot (v) Order
3. Transfer Function Modeling of (i) Electrical (ii) Mechanical (iii) Electromechanical systems.
4. Explain the derivation of analogues networks using (i) Force Voltage (ii) Force Current analogy.
5. Derive the analogous electrical networks for different mechanical systems based on (i) Force Voltage (ii) Force Current analogy
6. Derive the transfer function for field control and armature controlled DC motor.
7. Explain the concepts of Zero state response, Zero Input response of a system.

8. Determine the transfer function of a system with multiple inputs and multiple outputs**.**
9. Introduction to time response (transient response and steady state response) of a control system
10. Explain the Impulse, step and ramp response of first order systems.

Unit-III

1. Define the following systems sketching their output waveform for a unit step input: (i) under damped system (ii) un damped system (iii) Over damped system (iv) critically damped system
2. Definition and derivation of various Time Domain Specifications
3. Time Domain Specifications of a Second Order System. Derivation of expressions for maximum overshoot, peak time, settling time and rise time in terms of ε, and ω_n.
4. Explain how steady state error of control system is determined.
5. Derive the expression for static error coefficients for different systems.
6. Explain the effect of adding poles and zeros to open loop and closed loop transfer function
7. Explain the importance of dominant poles of transfer function.
8. Explain how the damping ratio affects the time response of a second order system?
9. Define the following terms (i) stable system (ii) unstable system (iii) critically stable system (iv) conditionally stable system.
10. Explain the concepts of asymptotic stability, impulse response stability, BIBO stability.

Unit-IV

1. Explain the R-H Criteria.
2. Problems to determine the stability of a system for different characteristic equation and determine the range of K for stability.
3. Introduction to Root Locus.
4. Rules for sketching root-locus for different order systems
5. Sketch the root-locus for different systems and stability range of K and different performance specifications.
6. Explain how to determine the transient performance specifications and the value of K for specified ξ, gain margin from the root locus.
7. Explain the impact of adding poles and zeros to the product of G(s)H(s) on the shape of the Root locus.
8. Determine the stability of a system for different characteristic equation and determine the range of K for stability.
9. Introduction to Frequency Domain Analysis. Co-relation between time domain and frequency domain
10. Define and derive the expression for bandwidth of a second order system. Derive the expressions for Resonant peak Mr , resonant frequency GƆr for the second order system in terms of ξ and GƆn.

Unit-V

1. What are Bode-Plots? State the advantages of Bode plots.
2. Explain the nature of bode plots for (i) Poles at origin (ii) simple pole (iii) simple zero
3. Explain the concept of gain margin and phase margin to determine the stability.Explain how these values help in studying relative stability
4. Draw the bode diagram for different open-loop transfer functions and mark the following on the bode diagram, recording the numerical values (i) gain crossover frequency (ii) phase margin (iii) Phase crossover frequency (ii) gain margin and discuss the stability
5. Derivation of Transfer Function from Bode magnitude Plot with problems.
6. Introduction to Polar Plots. Explain polar plots for Type 0, 1, 2 systems. Explain how type of a system determines the nature of polar plot

7. Explain how to obtain gain margin and phase margin from polar plots and discuss the stability.
8. Explain the concepts Pole-zero configurations, concept of encirclement, analytical function and singularities, mapping theorem.
9. Explain Nyquist stability criterion and explain the advantages of Nyquist method?
10. Draw Nyquist plots and discuss the stability of closed loop system from the given open-loop transfer system

Course Articulation Matrix (CAM)

Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Do the linear modeling (Transfer Function) for Electrical, Mechanical & Electromechanical systems with the analogy.	**L2**	H	H	M	_	M	_	L	_	M	_	-	H
2	Do the analysis of the second order system with the transient & steady state performance specification & its importance	**L1**	H	L	M	_	H	_	M	_	M	_	M	H
3	Do the stability analysis of different systems with RH criterion & Root locus technique	**L4**	H	L	M	_	L	_	H	_	M	_	-	H
4	Dothe frequency response analysis using analytical & Bode diagram	**L3**	H	L	M	_	L	_	H	_	M	_	-	H
5	Do therelative stability analysis using Polar &Nyquist diagrams.	**L3**	H	L	M	_	L	_	H	_	M	_	-	H
L-Low, M-Moderate, H-High													

Course Assessment Matrix(CAM)

Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Do the linear modeling (Transfer Function) for Electrical, Mechanical & Electromechanical systems with the analogy.	**L2**	3	3	2	_	2	_	1		2	_	-	3
2	Do the analysis of the second order system with the transient & steady state performance specification & its importance	**L1**	3	1	2	_	3	_	2		2	_	2	3
3	Do the stability analysis of different systems with RH criterion & Root locus technique	**L4**	3	1	2	_	1	_	3		2	_	-	3
4	Dothe frequency response analysis using analytical & Bode diagram	**L3**	3	1	2	_	3	_	2		2	_	2	3
5	Do therelative stability analysis using Polar &Nyquist diagrams.	**L3**	3	1	2	_	3	_	2		2	_	2	3
1-Low, 2-Moderate, 3-High													

Course Title: Electrical Machines –II			
Course Code:P15EE53	**Semester: V**	**L-T-P-H(Hrs): 4-0-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course learning objectives

1. To know about basic operation and construction of different types of DC Generators.
2. To know about basic operation and construction of different types of DC Motors.
3. Analysis of various tests to be conducted on DC Machines.
4. To study about voltage regulation of synchronous generators.
5. To learn about principle of operation and the effect of load variation in synchronous motors.

Course content

Unit-I

DC Generator: Types of generators, Types of armature windings, EMF Equation**,** O.C.C and Load characteristics, Armature reaction and methods of reducing its effects. Ideal, Resistance and EMF Commutation, Use of Interpoles, Compensating winding, Losses, Efficiency. **10Hrs**

Unit-II

DC Motor: Back EMF and its significance, Torque equation**,** Characteristics of Shunt, Series and Compound motors, Factors controlling motor speed, Rheostatic Speed Control of shunt and series motors, its Merits & Demerits, Starters, Three point and Four point starter, Applications of DC motor. **10Hrs**

Unit-III

Testing Of DC Machines: Direct and Indirect methods of testing of shunt and series motors: Swinburne's test, Hopkinson's test, Field test, Retardation test, Advantages and Disadvantages

Special Machines: Construction, principle of operation and applications of: Permanent magnet DC motor, Brushless DC motor, Stepper motor, Universal Motor. **10Hrs**

Unit-IV

Synchronous Generator: Principle of operation, Construction of salient & non-salient pole machines, armature windings, reduction in harmonics by Coil span factor, Distribution factor, Chorded coils and EMF equation, Introduction to harmonics & Reduction of harmonics.

Voltage Regulation: Significance, EMF, MMF & ZPF methods **10Hrs:**

Unit-V

Salient Pole Synchronous Machine: Two reaction theory, Power angle diagram, Reluctance power, Slip test.

Synchronization: Parallel operation of alternators: Reasons & Conditions, Synchronization to Infinite Bus.

Synchronous Motor: Principle of operation, Motor on load with constant Excitation, Power Flow equations, Synchronous motor with different Excitation, Different Torques of Synchronous Motor, Effect of Increased load with constant excitation and vice versa, Hunting & Damper Windings and inverted V curves, applications. **10Hrs**

Text Books:

1. AshfaqHussain "Electrical Machines", DhanapathRai& Co,3rd Edition, Reprint 2015.
2. B.L Theraja "Electrical Technology" Volume 2 ,S. Chand, 22nd Edition.

Reference Books:

1. A. Langsdorf "Theory of alternating current machinery" TMH, 2005.
2. M.G.Say "Performance and design of A.C. Machines" C.B.S Publishers, 2002.

Course Outcomes

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

1. To know about basic operation and construction of different types of DC Generators.
2. To know about basic operation and construction of different types of DC Motors.
3. Analysis of various tests to be conducted on DC Machines.
4. To study about voltage regulation of synchronous generators.
5. To learn about principle of operation and the effect of load variation in synchronous motors.

Topic Learning Objectives

After learning all the topics of unit – I, the student is able to

1. Know about various types of Generator.
2. Explain the Characteristics of D.C.Generator.
3. Explain the armature reaction & methods to reduce its effects
4. Explain the concept of Commutation & methods to improve it.
5. Discuss the various loses occurred in Generator.
6. Know the use of Interpoles& Compensating winding in D.C. Generator

After learning all the topics of unit – II, the student is able to

1. Explain Back EMF & its significance.
2. Discuss and analyze the various characteristics of D.C. Motors.
3. Discuss and compare the various methods of speed control of D.C. Mo-tors

After learning all the topics of unit – III, the student is able to

1. Explain the different types of testing of D.C. Machines.
2. Analyze the constructional features and operation principles of different types of special electrical motors.
3. Compare Direct and Indirect testing of D.C. Machines.
4. Discuss pros and cons of various tests on D.C. machines.

After learning all the topics of unit – IV, the student is able to

1. Explain the constructional features and operation principle of Alternator.
2. Understand the Voltage Regulation and its significance..
3. Compare the various types of armature winding of Alternator.
5. Determine the regulation of an alternator by various methods.
6. Discuss the advantages and limitations of various methods of finding regulation.

After learning all the topics of unit – V, the student is able to

1. Describe the importance Synchronization of Alternators.
2. Derive the basic synchronizing power equation.
3. Know the conditions for Synchronization.
4. Explain the operating principle of synchronous motor.
5. Discuss V curves and inverted V curves.
6. Explain various tests on synchronous motor

Review Questions

1. Explain the phenomenon of armature reaction in a D C Machine.
2. Explain the process of reversal of current during commutation.
3. Discuss the methods to reduce the effect of armature reaction.
4. Explain the methods to improve the commutation.
5. Explain the characteristics of D.C. Generator.
6. Derive the torque equation of D.C. Motor.
7. Explain the significance of Back emf.
8. Explain the characteristics of D.C. Shunt motor.

9. Discuss the different methods of speed control of D.C. series motor.
10. Discuss the applications of D.C. motors.
11. Explain how the efficiency is determined for DC machines by Hopkinson's test.
12. Discuss the advantages and disadvantages of Swinburne's Test.
13. Explain the constructional features of permanent magnet d.c motor.
14. Explain the working principle of Reluctance motor.
15. Explain how the field test is conducted on d.c series motor.
16. Discuss the different types of armature windings used in alternator.
17. Mention the methods used to reduce Harmonics in three phase alternator.
18. Compare salient pole type and non-salient pole type of alternator.
19. Describe the synchronous impedance method to determine regulation of an alternator.
20. Deduce the expressions for distribution factor and pitch factors.
21. Explain how an alternator is synchronized with bus bar.
22. Explain the slip test on salient pole synchronous machines.
23. Write a note on V and inverted V curves of synchronous motor.
24. Explain the operation of synchronous motor at constant load with variable excitation and vice-versa for both generating and motoring mode.
25. Explain the operating characteristics of synchronous motor.
26. What is prime mover?
27. Give the materials used in machine manufacturing
28. How will you change the direction of rotation of a d.c motor?
29. What is back emf in d.c motors?
30. Under what condition the mechanical power developed in a dc motor will be maximum?.
31. What is the function of a no-voltage release coil provided in a dc motor starter?
32. Name the two types of automatic starters used for dc motors.
33. Enumerate the factors on which the speed of a dc motor depends.
34. List the different methods of speed control employed for dc series motor
35. Name the different methods of electrical breaking of dc motors.
36. Under what circumstances does a dc shunt generator fail to build up?
37. To what polarity the interpoles excited in dc motors?
38. What is back emf in d.c motors?
39. Name any four applications of DC series motor.
40. Why DC motors are not operated to develop maximum power in practice?
41. Name the starters used for series motors.
42. Name Different types of starters.
43. Name the Protective devices in a starter.
44. What are the modification in ward Leonard linger system?
45. What type of DC motors are suitable for various torque operations?
46. Define speed regulation.
47. What are the performance curves?
48. To what polarity are the interpoles excited in dc generators?
49. Why are carbon brushes preferred for dc machines?
50. What are various types of Commutation?

Lesson Plan

Unit – I

1. Working Principle of D.C Generator, Types of D.C. Generator
2. Types of Armature windings, EMF Equation
3. O.C.C of D.C Generator &Load characteristics of D.C Generator.
4. Armature reaction and its effects
5. Methods to reduce the Armature reaction

6. Ideal Commutation and methods to improve commutation
7. Use of Interpoles and Compensating winding
8. Problems
9. Problems
10. Problems

Unit – II

1. Back EMF & its Significance
2. Torque Equation, Types of D.C. Motors
3. Characteristics of D.C. Series
4. Characteristics of Compound Motor
5. Speed Control of D.C. Shunt motor
6. Speed control of D.C.series Motor
7. Problems
8. Problems
9. Problems
10. Problems

Unit – III

1. Direct and indirect methods of testing shunt and series motors
2. Swinburne's Test, Hopkinson's Test
3. Field Test ,Retardation Test
4. Advantages and Disadvantages of different Tests
5. Construction, principle of operation and applications of :
6. Permanent magnet DC motor,
7. Brushless DC motor,
8. Stepper motor,
9. Universal Motor.
10. problems

Unit – IV

1. Construction of salient & non-salient pole machines
2. Voltage regulation & its Significance
3. Voltage regulation by EMF method
4. Voltage regulation by MMF method
5. Voltage regulation by ZPF method
6. Problems
7. Problems
8. Introduction to harmonics & Reduction of harmonics
9. Problems
10. Problems

Unit – V

1. Two reaction theory, Power angle diagram
2. Describe the importance Synchronization of Alternators.
3. Derive the basic synchronizing power equation.
4. Know the conditions for Synchronization.
5. Explain the operating principle of synchronous motor.
6. Alternator connected to infinite bus bar
7. Parallel operation of alternator &Synchronizing power
8. Discuss V curves and inverted V curves.
9. Hunting & Damper Windings and inverted V curves,
10. problems

Course assessment Matrix(CAM)													
Course Outcome - CO		**Program Outcome** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1 To know about basic operation and construction of different types of DC Generators	**L2**	2	1	2	3	-	-	1	-	-	-	2	-
2 To know about basic operation and construction of different types of DC Motors	**L2**	1	1	2	3	-	-	1	-	-	-	-	-
3 Analysis of various tests to be conducted on DC Machines	**L5**	2	1	3	2	-	-	2	-	-	-	-	-
4 To study about voltage regulation of synchronous generators. .	**L4**	3	2	2	3	-	-	-	-	2	-	-	-
5 To learn about principle of operation and the effect of load variation in synchronous motors.	**L4**	2	3	2	1	-	-	-	-	-	-	-	-
1-Low, 2-Moderate, 3-High													

Course Articulation Matrix (CAM)													
Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1 To know about basic operation and construction of different types of DC Generators	**L2**	**M**	**L**	**M**	**H**	**-**	**-**	**L**	**-**	**-**	**M**	**-**	**-**
2 To know about basic operation and construction of different types of DC Motors	**L2**	**L**	**L**	**M**	**H**		**-**	**L**	**-**	**-**	**-**	**-**	**-**
3 Analysis of various tests to be conducted on DC Machines	**L5**	M	**L**	**H**	**M**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**-**
4 To study about voltage regulation of synchronous generators.	**L4**	**H**	**M**	**M**	H	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**-**
5 To learn about principle of operation and the effect of load variation in synchronous motors.	L4	M	H	M	L	-	-	-	-	-	-	-	-
L-Low, M-Moderate, H-High													

Course Title: Power Transmission & Distribution			
Course Code:P15EE54	**Semester: V**	**L-T-P-H(Hrs): 4-0-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives(CLOs)

This course aims to:

1. To understand about the transmission and distribution system scheme
2. understand and study the effect of sag and tension on over head transmission line
3. To study and understand about line insulators and UG cables
4. To understand and study the performance evaluation of OH lines having different configurations.
5. To study the calculation of line parameter values of 1-phase and 3-phase OH lines of different configuration.
6. To understand and study the concept of corona and its impact on OH transmission line.
7. To understand and study about DC and AC- distributors carrying point and/or uniformly varying load.

Course Content

Unit – I

Typical Transmission and Distribution System Scheme: Single line diagram of typical transmission and distribution system scheme indicating various voltage levels, Standard voltages for transmission, Selection of optimal value of transmission voltage, Advantages of high voltage transmission, Effect of increase of transmission voltage on: i) volume of copper used ii) efficiency of transmission iii) line loss and regulation.

Overhead Transmission Line: Study of requirements and types of line conductors, Line supports, Sag calculation in conductors i) suspended on level supports ii) supports at different levels; Effect of wind & ice on sag tension calculations, Tension & sag at erection, Stringing charts. **10hrs**

Unit- II

Insulators: Requirement, Types & constructional features of insulators, Potential distribution over a string of suspension insulators, String efficiency & methods of improving it, testing of insulators.

Underground Cables: Types, Material used, Insulation resistance, Thermal rating of cables, Charging current, Grading of cables –capacitance grading &inter-sheath grading, Testing of cables. **10hrs**

Unit – III

Line Parameters : Brief review of concept of resistance, inductance and capacitance, Calculation of inductance of single phase & three phase lines with equilateral & unsymmetrical spacing, Inductance of composite conductor lines, Calculation of capacitance for 2- wire & 3-wire lines with equilateral & unsymmetrical spacing, Skin effect & Proximity effect**.** **10hrs**

Unit – IV

Performance of Power Transmission Lines: Brief review of characteristics & types of transmission lines, Regulation of short transmission line, Medium transmission line using nominal T-method, end condenser method, ð-method, Long transmission line-ABCD constants, Power flow through transmission lines, P-V & P-Q coupling, Ferranti effect, performance of ring transmission lines. **10hrs**

Unit –V

Corona: Phenomenon of corona, Expression for disruptive & visual critical voltage, Corona power loss, Factors effecting corona power loss, Advantages and disadvantages of corona, Methods of reducing corona effect, Radio interference, and effects of corona on transmission line design.

Distribution System (DS):Typical distribution system scheme, Feeders, distributors & service mains; Requirements of distribution system, Primary and secondary distribution systems; Radial & ring main systems, DC distributors, Calculation for concentrated loads and uniformly varying loads, AC Distributors- when the load pfs referred to voltages at load points, when the load pfs referred to supply voltage point.. **10hrs**

Text Books:

1. A Chakrabarti, Soni, Guptha & Bhatnagar, A course in electrical power – DhanpatRai & Co (New Delhi), 2nd edition, 2012.
2. C L Wadwa, Electrical power systems –New Age Publishers, 6th edition, 2010.

Reference Books:

1. Dr. S L Uppal& S Rao, Electrical Power –Khanna publications, 15th edition, 2001.
2. S M Singh, Electrical Power generation, transmission and distribution –PHI, 2nd edition, 2011

Course Outcomes (COs)

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

CO1: Recognize the structure and operation of electricity generation, transmission and distribution systems and its impact on the society and environment.

CO2: Students are able to analyze the various power transmission methods involved in the power system

CO3: Solve problems involving modeling, mechanical and electrical design and performance evaluation of power transmission lines.

CO4: Calculation of line parameters for the 1-phase and 3-phase systems, considering different configurations.

CO5: Analyze the importance of overhead and underground transmission systems.

CO6: Calculation of the capacitance and stress levels to solve simple designing problems of single and three core underground cables.

CO7: To analyze the causes and effects of corona phenomenon on OHT lines, precautions to be taken to eliminate it.

CO8: To analyze various types of power DSs,

Topic Learning Objectives(TLOs)

After learning all the topics of unit-I, the student is able to:

1. To draw the single line diagram of typical transmission and distribution system scheme indicating various voltage levels
2. Know Standard voltages for transmission
3. How to Select optimal value of transmission voltages
4. Understand advantages of high voltage transmission
5. Effect of increase of transmission voltage on: i) volume of copper used ii) efficiency of transmission iii) line loss and regulation.
6. Requirements and types of line conductors, Line supports,
7. Calculate sag in conductors i) suspended on level supports ii) supports at different levels;
8. Analyze the Effect of wind & ice on sag tension calculations, Tension & sag at erection, stringing charts.

After learning all the topics of unit – II, the student is able to:

1. Understand the Requirement, Types and constructional features of insulators
2. Analyze Potential distribution over a string of suspension insulators,
3. Calculate the String efficiency and methods to improving it
4. Know Procedure for testing of insulators.
5. Learn material commonly used to manufacture different types of UG cables.
6. Understand about derivation of expression for insulation resistance, thermal rating
7. Able to derive expression for charging current in cables
8. Understand meaning of grading of cables and various methods of grading

9. The procedure for testing of cables

After learning all the topics of unit – III, the student is able to:

1. Understand meaning of resistance, inductance and capacitance
2. Derive the expression to calculate inductance value of single phase & three phase lines with equilateral & unsymmetrical spacing, Inductance of composite conductor lines
3. Calculate the capacitance value for 2- wire & 3-wire lines with equilateral & unsymmetrical spacing
4. Can understand the meaning of Skin effect & Proximity effect

After learning all the topics of unit – IV, the student is able to:

1. Understand the basis for OH transmission classification
2. Derive the expression for regulation of short transmission line
3. Calculate the ABCD parameters of- Medium transmission line using nominal T-method, end condenser method, ð-method
4. Calculate the ABCD parameters of Long transmission line
5. Understand the power flow through transmission lines, P-V & P-Q coupling
6. Meaning of Ferranti effect, Evaluate the performance of ring transmission lines.

After learning all the topics of unit – V, the student is able to:

1. Understand about the phenomenon of corona in OH transmission line
2. Derive the Expressions for disruptive and visual critical voltages
3. What is Corona power loss and factors effecting corona power loss,
4. Can understand advantages and disadvantages of corona
5. Employ the methods of reducing corona effect,
6. Understand what is radio interference, and how the effects of corona are taken into Consideration while designing transmission line.
7. To draw a Typical distribution system scheme indicating Feeders, distributors & service mains
8. Can understand the characteristics of distribution system
9. Can differentiate between Primary and secondary distribution systems; Radial & ring main systems
10. To analyze the DC distributors with concentrated loads and uniformly varying loads
11. To analyze AC Distributors for the cases when the load pfs referred to voltages at load points and to supply voltage point

Review Questions

1. Draw the line diagram of a typical power supply scheme indicating the standard voltages
2. Bring out the difference between HVAC and HVDC transmission systems.
3. Discuss the advantages of high transmission voltage and also calculate the volume of the conductor material required for 1- ϕ, 2 wire A.C. system with one conductor earthed for overhead transmission system
4. Explain, what is sag, and why it is inevitable in overhead transmission line? What are the factors influencing it?
5. With usual notations derive an expression for maximum sag of a transmission line where the supports are at same level.
6. An overhead transmission line at a river crossing is supported from two towers at heights of 25 m and 75 m. If the required clearance between conductor and water midway between the towers is 45 m and if both the towers are on the same side of the point of maximum sag of the parabolic configuration, Find the stringing tension in the conductor. Weight of conductor = 0.7 kg/m, Distance between towers = 250 m
7. Discuss the affect of wind and ice coating on calculation of sag
8. Write short note on stringing chart and its application
9. Why are insulators used with over head lines? Discuss the desirable properties of insulators and name the types of insulators.

10. Define string efficiency. How the string efficiency is improved? Explain any two methods
11. Distinguish between underground cable and overhead transmission systems
12. Show that the potential distribution across the string of suspension insulators is not uniform. Consider 4 insulator units
13. Each line of a 3 phase system is suspended by a string of 3 similar insulators. If the voltage across the line unit is 17.5 kV, calculate the line to neutral voltage. Assume that the shunt capacitance between each insulator and earth is $\frac{1}{8}^{th}$ of the capacitance of the insulator itself. Also find the string efficiency
14. Write short notes on testing of insulators
15. What is meant by grading of cables? Briefly explain various methods of grading
16. Derive an expression for insulation resistance of a cable.
17. Derive the expression for capacitance of a single core cable
18. A single core cable has a conductor diameter of 2.5 cm and a sheath of inside diameter of 6cm. calculate the maximum stress
19. A single core cable 1km long has a core diameter of 0.5cm and under sheath diameter of 2cm. the relative permittivity of insulating material is 3.5. The power factor on open circuit is 0.05 and the supply voltage is 11kv, 50Hz. Determine: (1) the capacitance of the cable (2) charging current (3) Dielectric loss (4) equivalent insulation resistance
20. Explain about the testing of
21. What is transposition of conductors and why it is needed?
22. Calculate the inductance of single phase two wire line starting from fundamentals
23. Derive the expression for inductance of a composite conductor lines
24. Explain the terms self and mutual GMDs
25. Derive an expression for inductance of a 3 phase line with unsymmetrical spacing and transposition using flux linkage concept
26. Derive an expression for capacitance of a 3 phase single circuit line with equilateral spacing
27. What is skin effect? What are the factors influencing skin effects?
28. The three conductors of a 3phase line are arranged at the three corners of a triangle of sizes 2m, 2.5 m and 4.5 m. Calculate the Inductance per km of the line when the conductors are regularly transposed the diameter of each conductor is 1.24 cm
29. Find the capacitance of a single phase line 40 km long consisting of 2 parallel wires each 4 mm in diameter and 2 m apart. Determine the capacitance of the same line taking into account, effect of ground. The height of conductors above ground is 5m
30. Discuss the effect of load pf on regulation of a 3-phase transmission line
31. What are ABCD constants? Derive an expression for ABCD constants of a medium transmission lines using nominal T_1 method. Show that AD – BC = 1.
32. A 3-phase line delivers 3000 Kw at a power factor of 0.8 lagging to a load. If the sending end voltage is 33 kV, determine: (1) Receiving end voltage (2) Line current (3) transmission efficiency. The resistance and reactance of each conductor is 5 ohm and 8 ohm, respectively
33. A balanced 3 phase load of 50 MW is supplied at 132 kV, 50 Hz and 0.8 P.F lagging by means of a transmission line. The series Impedance of a single conductor is (20 + j50) ohms and the total phase neutral admittance is 310 $x10^{-6}$ mho using T-method. Determine ABCD constants of the line, sending end voltage, regulation of the line
34. What is Ferranti effect, explain
35. What is corona? Derive expression for the disruptive critical voltage and visual critical voltage
36. State and explain any four factors affecting corona and corona power loss (L1).
37. Mention the advantages and disadvantages of corona. State methods of reducing corona effect.

38. A 132 kV, 3 phase line with 1.956cm diameter conductors in built so that corona takes place, if the line voltage exceeds 210 kV (r.m.s). If the value of potential gradient at which ionization occurs can be taken as 30 kV/cm. Find the spacing between the conductors.
39. Write short note on feeders, distributors and service mains.
40. How D.C. distributors are classified? Write the relative merits and demerits of ring main over radial distribution systems.
41. A two wire D.C. distribution system is 4 km long and it supplies load of 250 A, 175 A, 100 A and 75 A at 1200 m, 1500 m, 3500 m and 4000 m from the feeding end A. Each conductor has go and return resistance of 0.00032 Ω per 100 m. Calculate the voltage at each load point if the voltage at the feeding end is 250 V.
42. A two wire DC distributor 100m long is loaded with 4A/m. The resistance of the single wire is 0.5 Ohm/km. Find the maximum voltage drop when the distributor is fed from both ends at equal voltages.
43. A 3-phase, 66kV station supplies load as shown in fig. 42. Calculate the current in each section. Power factors of loads are referred to point A.

Lesson Plan

Unit-I

1. Single line diagram of typical transmission and distribution system scheme indicating various voltage levels, Standard voltages for transmission
2. Selection of optimal value of transmission voltage, Advantages of high voltage transmission,
3. Effect of increase of transmission voltage on: i) volume of copper used ii) efficiency of transmission iii) line loss and regulation;
4. Study of requirements and types of line conductors, Line supports
5. Sag calculation in overhead conductors i) suspended on level supports
6. ii) supports at different levels; Effect of wind & ice on sag tension calculations ,
7. Tension & sag at erection, Stringing charts.
8. Solution of Numerical problems
9. Solution of Numerical problems
10. Solution of Numerical problems

Unit-II

1. Types, Material used, Insulation resistance, Thermal rating of cables
2. Charging current, Grading of cables –capacitance grading & inter-sheath grading,
3. Testing of cables.
4. Requirement, Types & constructional features of insulators,
5. Potential distribution over a string of suspension insulators, String efficiency
6. Methods of improving it, testing of insulators.
7. Solution of Numerical problems
8. Solution of Numerical problems
9. Solution of Numerical problems
10. Solution of Numerical problems.

Unit-III

1. Brief review of concept of resistance, inductance and capacitance, Calculation of inductance of single phase line
2. Calculation of inductance of three phase lines with: a) equilateral spacing, b) Unsymmetrical spacing,
3. Inductance of composite conductor lines,
4. Calculation of capacitance for 2- wire line
5. Calculation of capacitance for 3-wire lines with equilateral & unsymmetrical spacing,
6. Skin effect & Proximity effect.
7. Solution of Numerical problems
8. Solution of Numerical problems

9. Solution of Numerical problems
10. Solution of Numerical problems

Unit-IV

1. Brief review of characteristics & types of transmission lines,
2. Regulation of short transmission line,
3. Medium transmission line using nominal T-method,
4. End condenser method, ð-method,
5. Long transmission line-ABCD Constants,
6. Power flow through transmission lines, P-V & P-Q coupling, Ferranti effect.
7. solution of Numerical problems
8. Solution of Numerical problems
9. Solution of Numerical problems
10. Solution of Numerical problems

Unit-V

1. Phenomenon of corona, Expression for disruptive & visual critical voltage
2. Corona power loss, Factors effecting corona power loss, Advantages and disadvantages of corona, Methods of reducing corona effect
3. Solution of Numerical problems
4. Solution of Numerical problems
5. Typical distribution system scheme, Feeders, distributors & service mains, Requirements of distribution system, Primary and secondary distribution systems
6. Radial & ring main systems, DC distributors, Calculation for concentrated loads and uniformly varying loads
7. AC Distributors: pfs referred to load point voltages, pfs referred to supply voltage point
8. Solution of Numerical problems
9. Solution of Numerical problems
10. Solution of Numerical problems

Course Articulation Matrix (CAM)

	Course Outcome – CO		Program Outcome (ABET/NBA-(3a-k))											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Recognize the structure and operation of electricity generation, transmission and distribution systems and its impact on the society and environment.	**L2**	**L**	**H**	**L**	**-**	**L**	**-**	**L**	**-**	**-**	**H**	**-**	**L**
2	Solve problems involving modeling, Mechanical and electrical design and performance evaluation of power transmission lines.	**L1**	**L**	**H**	**L**	**-**		**-**	**L**	**-**	**-**	**-**	**-**	**L**
3	Calculate the capacitance and stress Levels to solve simple designing problems of single and three core underground cables.	**L4**		**L**	**L**	**-**	**L**	**-**	**L**	**-**	**-**	**-**	**-**	**L**
4	Analyze the importance of overhead and underground transmission system.	**L3**	**L**	**H**	**L**		**L**	**-**	**L**	**-**	**M**	**-**	**-**	**L**
L-Low, M-Moderate, H-High														

Course assessment Matrix(CAM)

	Course Outcome - CO		Program Outcome (ABET/NBA-(3a-k))											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Recognize the structure and operation of electricity generation, transmission and distribution systems and its impact on the society and environment.	**L1**	**1**	**3**	**1**	**-**	**1**	**-**	**1**	**-**	**-**	**3**	**-**	**1**
2	Solve problems involving modeling, Mechanical and electrical design and performance evaluation of power transmission lines.	**L2**	**1**	3	**1**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
3	Calculate the capacitance and stress Levels to solve simple designing problems of single and three core underground cables.	**L3**	**1**	**1**	**1**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
4	Analyze the importance of overhead and underground transmission system.	**L4**	**1**	**3**	**1**	**2**	**1**	**-**	**1**	**-**	**2**	**-**	**-**	**1**
1-Low, 2-Moderate, 3-High														

Course Title: Operational Amplifiers & Linear Integrated Circuits			
Course Code:P15EE551	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

UNIT – I

OP-AMPS AS AC AMPLIFIER: Capacitor coupled voltage follower, High Z_{in} capacitor coupled - voltage follower, non-inverting amplifier, inverting amplifier; Capacitor coupled inverting amplifier, setting upper cut off frequency, Capacitor coupled difference amplifier, Use of single polarity supply. **10hrs**

UNIT - II

OP-AMPS FREQUENCY RESPONSE AND COMPENSATION : Op-amp circuit stability, Frequency and phase response, Frequency compensating methods , Manufacturer's recommended compensation, Op-amp circuit band width, Slew rate effects, Stray & load capacitance effects, Z_{in} mod compensation, Circuit stability precautions. **10hrs**

UNIT - III

SIGNAL PROCESSING & GENERATOR CIRCUITS: Precision half wave & full wave rectifiers, Limiting circuits, Clamping circuits, Peak detectors, Sample & hold circuit. Triangular & rectangular wave generator, Waveform generator design, Phase shift oscillator, Oscillator amplitude stabilization, Wein bridge oscillator, Signal generator output controllers. **10hrs**

UNIT - IV

OPAMPS-NONLINEAR CIRCUITS & ACTIVE FILTERS: Op-amps in switching circuits, Zero crossing detectors, Inverting & non inverting Schmitt trigger, As table & monostable multi vibrators. First and second order high pass and low pass filters, Band pass filter, Band stop filter. **10hrs**

UNIT - V

SPECIALIZED IC APPLICATIONS: Universal active filter, Switched capacitor filter, Phase locked loops & its applications, Power amplifiers

DC VOLTAGE REGULATORS: Basics of Voltage regulators, Voltage follower regulator, Adjustable output regulator, Precision voltage regulators and Integrated circuit voltage regulators **10hrs**

Text Books:

1. "Operational amplifiers and linear IC's"- David A Bell, -PHI, 4th edition, 2011
2. "Operational amplifiers and linear" - Ramakanth A Gayakwad,- IC's, Pearson Education, 4th edition, 2012

Reference Books:

1. Operational amplifiers and linear IC's- Roy & Choudhry, New age International, 4th edition, 2007
2. Operational amplifiers and linear IC's - Stanley William D, Pearson Education, 4th edition, 2007
3. Operational amplifier and linear integrated circuits - K. Lalkishore -Pearson education, 5th edition, 2008

Course Title:Fuzzy Logic			
Course Code:P15EE552	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Classical / Crisp sets and Fuzzy sets: Classical sets. Operations on Classical Sets, Properties of Classical Sets, mapping of classical sets to functions; Fuzzy sets –member ship functions for fuzzy set. Properties of Fuzzy sets, Operations in Fuzzy Sets. Examples of fuzzy sets for different engineering applications. **10hrs**

Unit-II

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. Tolerance and Equivalence Relations - Crisp Tolerance and Equivalence Relations, Fuzzy Tolerance and Equivalence Relations. The Extension Principle. **10hrs**

Unit-III

Membership functions: Introduction, Features of Membership Functions, Fuzzification, Methods of Membership Value Assignments, and 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. **10hrs**

Unit-IV

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. **10hrs**

Unit-V

Fuzzy Logic Control system: Introduction, Simple fuzzy logic controllers. General fuzzy logic controllers. 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.**10hrs**

Text Books:

1. Timothy J. Ross, "Fuzzy logic with Engineering applications"**,** McGraw-Hill/Wiley India Publications.2nd Edition. 2009.

2. S.N.Shivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley India publications, First edition 2007.

Course Title: Operation Research			
Course Code:P15EE553	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

UNIT – I

Introduction and Overview of the Operations Research Modeling Approach: The Origins of Operations Research, the Nature of Operations Research, the Impact of Operations Research, Algorithms and OR Courseware, Defining the Problem and Gathering Data, Formulating a Mathematical Model, Deriving Solutions from the Model, Testing the Model, Preparing to Apply the Model, Implementation.

Introduction to Linear Programming: Prototype Example, the Linear Programming Model, Assumptions of Linear Programming

Solving Linear Programming Problems: The Simplex Method: The Essence of the Simplex Method, Setting Up the Simplex Method, The Algebra of the Simplex Method, The Simplex Method in Tabular Form, Tie Breaking in the Simplex Method Adapting to Other Model Forms, Post–optimality Analysis, Computer Implementation.

Text: 1.1 to 1.4, 2.1 to 2.6, 3.1 to 3.3 and 4.1 to 4.8 **11 Hrs**

UNIT – II

Duality Theory and Sensitivity Analysis: The Essence of Duality Theory, Economic Interpretation of Duality, Primal–Dual Relationships, Adapting to Other Primal Forms, the Role of Duality Theory in Sensitivity Analysis, the Essence of Sensitivity Analysis, Applying Sensitivity Analysis.

The Transportation and Assignment Problems: The Transportation Problem, a Streamlined Simplex Method for the Transportation Problem, the Assignment Problem, a Special Algorithm for the Assignment Problem. Text: 6.1 to 6.7, 8.1 to 8.4 **11 Hrs**

UNIT – III

Network Optimization Models: Prototype Example, The Terminology of Networks, The Shortest–Path Problem, The Minimum Spanning Tree Problem, The Maximum Flow Problem, The Minimum Cost Flow Problem, The Network Simplex Method and A Network Model for Optimizing a Project's Time–Cost Trade–Off. Text: 9.1 to 9.8 **10 Hrs**

UNIT – IV

Queuing Theory: Prototype Example, Basic Structure of Queuing Models, Examples of Real Queuing Systems and The Role of the Exponential Distribution, the Birth–and–Death Process and Queuing Models Based on the Birth–and–Death Process, Queuing Models Involving Non–exponential Distributions, Priority–Discipline Queuing Models, Queuing Networks and the Application of Queuing Theory. Text: 17.1 to 17.10 **10 Hrs**

UNIT – V

Dynamic Programming: A Prototype Example for Dynamic Programming, Characteristics of Dynamic Programming Problems, Deterministic Dynamic Programming, Probabilistic Dynamic Programming Conclusions.

Game Theory: The Formulation of Two–Person, Zero–Sum Games, Solving Simple Games – a Prototype Example, Games with Mixed Strategies, Graphical Solution Procedure, Solving by Linear Programming. Text: 10.1 to 10.4, 14.1 to 14.4 **10 Hrs**

TEXT BOOK:

1. "Introduction to Operations Research", Frederick S. Hiller, Gerald J. Lieberman, Tata McGraw Hill, 9th Edition, 2015.

REFERENCE BOOKS:

1. "Operations Research An introduction", Hamdy A. Taha, Prentice Hall of India, 9th Edition, 2011.
2. "Operations Research", Schaum's Series Bronson and Naadimuthu, Tata Mcgraw Hill, 2nd Edition, 2011

Course Title: Management And Entrepreneurship			
Course Code:P15EE554	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

Unit – I

a) Introduction to Management: Scope and functional areas of management, management as a science, art or profession. Management and administration, role of management, levels of management, development of Management thought, early management approaches, modern management approaches

b) Planning: Nature of planning, Importance of Planning, forms of planning, types of plans, steps in planning, limitations of planning, making planning effective, planning skills, strategic planning in Indian industry, meaning of a decision, types of decisions, steps in rational decision making.

10hrs

Unit – II

a)Organization: Nature and purpose of organization, principles of organization, types of organization, departmentation, need and significance of departments, process involved in departmentation, demerits of departmentation, methods or basis of departmentation, span of management and span of control, factors influencing the span of control, authority, responsibility, centralization and decentralization, factors determining centralization of authority, advantages of centralization, disadvantages of centralization, decentralization, advantages of decentralization, disadvantages of decentralization, balancing between centralization & decentralization.

b)**Staffing:** Nature of staffing, responsibility of staffing, process of staffing, need and importance of staffing, recruitment, process of recruitment, factors affecting recruitment, recruitment policy, principles of recruitment policy, constraints on recruitment, selection, need or importance of selection, selection procedure, difference between recruitment & selection, management by objectives (MBO), features & process of MBO, benefits of management by objectives, limitations of management by objectives. **10hrs**

Unit – III

a) Directing

Introduction, Meaning of directing, Nature and characteristics of direction, Principles of effective direction, importance of direction, techniques of directing, motivation, nature of motivation, types of motivation, importance of motivation, theories of motivation, Leadership, nature & characteristics of leadership, types of leaders, formal & informal leaders, leadership functions, qualities of a good leader, importance of leadership in management

b)Controlling

Control- Importance of control system & characteristics of control, steps in controlling, limitations of control, essentials of a sound control system and methods of establishing control. Communication- characteristics of communication, elements of communication, process and purpose of communication, importance of communication, types of communication, coordination- features or characteristics of co-ordination, aims and importance of communication, need for communication, types of communication, techniques of co-ordination,. **10hrs**

Unit – IV

Entrepreneurship

a) Meaning of entrepreneurs, evaluation of the concept, functions, and types of entrepreneur. Development of entrepreneurship, stages of entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India.

b) Small Scale Industry- Definition, characteristics, need, objectives, role of small scale industry in economic development, steps to start an small scale industry, different policies of small scale industry, institutional support and different schemes. **10hrs**

Unit – V

a)Woman Entrepreneur

Concept of woman entrepreneurs, functions of woman entrepreneurs**,** factors influencing **w**oman entrepreneurs, leadership qualities for a woman entrepreneurs, psycho-social barriers for woman

entrepreneurs, basic problems of woman entrepreneurs, association promoting woman entrepreneurs, case studies of Indian successful entrepreneurs.

b)Preparation of project

Meaning of project, project identification, project selection, project report, need & significance of report, contents, formulation, guide lines by planning commission for project report, project appraisal, identification of business opportunities. **10hrs**

Text Books:

1. P C Tripati, "Principles of Management", PN Reddy, Tata McGraw Hill, 2007Vasant Desai, " Dynamics of Entrepreneurial Development & Management", Himalaya publishing House .2007 Edition

Reference Books:

1. S S Khanka, "Entrepreneurship Development" S Chand & Co, 2011.Dr. NVR Naidu and T.KrishnaRao, "Management and Entrepreneurship"- I K International Publishing House Pvt. Ltd., New Delhi, 2008

Course Title: Utilization of Electrical Power			
Course Code:P15EE561	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

Unit – I

Heating and Welding: Introduction, mode of heat transfer, advantages and methods of electric heating, resistance 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. **10Hrs**

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, Sodium vapour, CFL, LED and their working. **10Hrs**

Unit – III

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

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. **10Hrs**

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. **10Hrs**

Text Books:

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

Reference books:

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

Course Title: Software Engineering			
Course Code:P15EE562	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

Unit – I

OVERVIEW: Introduction to Software Engineering, Introduction, Professional software development ,Software engineering ethics, Case studies.

Software processes: Software process models, Process activities, Coping with change, The Rational Unified Process. **8 Hrs**

Unit – II

Agile software development: Agile methods, Plan driven and agile development, Extreme programming, Agile project management, Scaling agile methods

Requirements engineering:

Functional and non-functional requirements, The software requirements document Requirements specification, Requirements engineering processes, Requirements elicitation and analysis, Requirements validation, Requirements management. **12 Hrs**

Unit – III

System modeling: Context models, Interaction models, Structural models, Behavioral models, Model-driven engineering.

Architectural design: Architectural design decisions, Architectural views, Architectural patterns, Application architectures **12 Hrs**

Unit – IV

Design and Implementation: Object-oriented design using the UML Design patterns, Implementation issues, Open source development

Software testing: Development testing, Test-driven development, Release testing, User testing. **10 Hrs**

Unit – V

Project management: Risk management, Managing people, Teamwork.

Configuration management: Change management, Version management System building, Release management. **8 Hrs**

Text book:

1. Software Engineering – Ian Somerville, 9th Edition, Pearson Education, 2012.

Reference books:

1. Software Engineering: A Practitioners Approach - Roger S. Pressman, 7th Edition, McGraw Hill, 2011
2. Software Engineering Theory and Practice - Shari Lawrence Pfleeger, Joanne M. Atlee, 3rd Edition, Pearson Education, 2014.
3. Software Engineering Principles and Practice – Waman S Jawadekar, Tata McGraw Hill, 2004
4. Software Engineering – PankajJalote, Tata McGraw Hill

Course Title: Electrical Material Science			
Course Code:P15EE563	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course content

UNIT I

Conductivity of Materials: Free Electron Theory of Metals; Ohm's Law and the Relaxation Time of Electrons; Factors affecting Resistivity of Metals; Emission of Electrons from Metals; Thermal Conductivity of Metals; Thermoelectric Effects; Superconductivity; Band Theory of Solids; Conduction in Liquids. **10hrs**

UNIT II

Dielectric Properties of Materials-1: The Static Dielectric Constant; Polarization and Dielectric Constant; Polarization Mechanisms; Behaviour of Dielectrics in Alternating Fields; Complex Dielectric Constant; Dipolar Relaxation; Dielectric Losses-Loss Tangent; Temperature and Frequency Dependence of Dielectric Constant. **10hrs**

UNIT III

Dielectric Properties of Materials-2: Breakdown Mechanisms in Gaseous, Liquid and Solid Dielectrics; Dielectric Strength; Temperature Classification of Insulating Materials; Properties of Insulators-Insulation Resistance; Volume Electrical Resistivity; Surface Electrical Resistivity; Ferro Electricity; Piezoelectricity. **10hrs**

UNIT IV

Magnetic Properties of Materials: Magnetization; Atomic Magnetic Moments; Classification of Magnetic Materials; Diamagnetic, Paramagnetic and Ferromagnetic Materials; Ferromagnetic Domains; Magnetization Curve; Soft and Hard Ferromagnetic Materials; Losses in Magnetic Materials; Factors Affecting Permeability and Hysteresis Loss; Anti-Ferromagnetism; Ferromagnetism; Magnetic Resonance. **12hrs**

UNIT V

Materials and their Applications: Properties of Various Conducting, Insulating and Magnetic Materials and their Applications; Superconducting Materials and their Applications; Special Purpose Materials; Thermocouple Materials; **10hrs**

Text books:

1. J. Dekker, "Electric Engineering Materials", Prentice Hall,2012
2. L. Solymer and D. Walsh, "Electric Properties of Materials", Oxford University Press, 2004

Reference books:

1. S. P. Seth, "A course in Electrical Engineering Materials", Dhanpat Rai Publication,2013\
2. William Smith," Foundation of Materials Science and Engineering", 3rd Edition, McGraw Hill, 2007. ISBN:9780073529240
3. Flexible Electronics: Materials and Applications, William S. Wong and Alberto Salleo, eds. ISBN 978-0-387-74362-2, 2009.

Course Title: Micro Electro Mechanical System			
Course Code:P15EE564	**Semester: V**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits - 4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course content

UNIT_I

Introduction to Microsystems:

Overview of microelectronics manufacture and Microsystems technology. Definition - MEMS materials. Laws of scaling. The multi disciplinary nature of MEMS. Survey of materials central to micro engineering. Applications of MEMS in various industries. **10Hrs**

UNIT_II

Micro sensors and actuators:

Working principle of Microsystems - micro actuation techniques - micro sensors – types – Microactuators – types – micropump – micromotors – micro – valves – microgrippers – microaccelerometers. **10Hrs**

UNIT_III

Fabrication process:

Substrates - single crystal silicon wafer formation – Photolithography – Ion implantation – Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition epitaxy - etching process. **10Hrs**

UNIT_IV

Micro system manufacturing:

Bulk Micro manufacturing - surface micro machining – LIGA – SLIGA - Micro system packaging materials - die level - device level - system level - packaging techniques – die preparation – surface bonding - wire bonding - sealing. **10Hrs**

UNIT_V

Microsystems design and packaging:

Design considerations, Mechanical Design, Process design, Realization of MEMS components using intellisuite. Micro system packaging, Packing Technologies, Assembly of Microsystems, Reliability in MEMS. **10Hrs**

TEXT BOOKS

1. Tai-Ran Hsu “MEMS and Microsystems Design and Manufacture” , Tata McGraw-Hill Publishing Company Ltd
2. Chang Liu, “Foundation of MEMS” , Pearson Education

REFERENCES

1. Rai - Choudhury P. “MEMS and MOEMS Technology and Applications”, PHI Learning Private Limited, 2009
2. Julian W. Gardner, Vijay K.Varadan, Osama O. Awadelkarim, “Micro Sensors MEMS and Smart Devices”, John Wiley & Sons Limited, 2002

Course Title: Power Electronics Lab			
Course Code:P15EEL57	**Semester: V**	**L-T-P-H(Hrs): 0-0-3-3**	**Credits –1.5**
Contact period : Lecture: 36Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives

This course aims to:

1. To study the working of different types of power semi-conductor devices and their switching characteristics.
2. To develop and analyze the different types of thyristor firing and commutation circuits.
3. To observe and analyze the operation and characteristics of various types of converter choppers, AC voltage controllers and Inverters.

List of experiments

1. Static characteristics of SCR and TRIAC
2. Static characteristics of MOSFET and IGBT
3. SCR turn on using synchronized UJT relaxation oscillator
4. Single phase Half control bridge rectifier operation with R-load & Motor load.
5. Single phase Full control bridge rectifier operation with R-Load & Motor load.
6. AC Voltage Controllers using Triac-Diac combination
7. Speed control of Universal motor /single phase Induction motor.
8. Speed control of a Stepper Motor.
9. Chopper operation with constant and variable Frequency Control.
10. Study of Commutation circuits.
11. Self study experiment

Course Outcomes

At the end of the course, students will:

CO1: Able to understand the working of various power electronic devices/switches for various applications.

CO2: Able to Design and develop the Firing circuits for various types of firing.

CO3: Able to Design and develop various types of commutation circuits

CO4: Able to operate and analyse the various types of power converter circuits with various types of loads

Topic learning Objectives

1. Analyze the basic switching operation of SCR AND TRIAC
2. Analyze the basic switching operation of MOSFET AND IGBT
3. Analyze the basic operation of UJT based firing circuit
4. Analyze the basic operation of Half control bridge rectifier operation with various loads.
5. Analyze the basic operation of Full control bridge rectifier operation with various loads.
6. Analyze the basic operation of AC Voltage Controllers with various loads.
7. Analyze the method of speed control of Universal motor
8. Analyze the method of speed control of Stepper Motor
9. Analyze the basic operation of DC-DC Power conversion
10. Analyze the basic operation of different types of Commutation circuits.

Course Articulation Matrix (CAM)													
Course Outcomes (CO)		**Program outcomes** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Able to understand the working of various power electronic devices/switches for various applications	M	H	M	H	-	-	L	-	M	-	-	-
2	Able to Design and develop the Firing circuits for various types of firing.	L	M	H	H	-	-	M	-	M	-	-	-
3	Able to Design and develop various types of commutation circuits	L	M	H	H	-	-	M	-	M	-	-	-
4	Able to operate and analyse the various types of power converter circuits with various types of loads	L	M	M	M	-	-	M	-	M	-	-	-
	L-Low, M-Moderate, H-High												

Course Assessment Matrix (CAM)													
Course Outcomes (CO)		**Program outcomes** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Able to understand the working of various power electronic devices/switches for various applications	2	3	2	3	-	-	1	-	2	-	-	-
2	Able to Design and develop the Firing circuits for various types of firing.	1	2	3	3	-	-	2	-	2	-	-	-
3	Able to Design and develop various types of commutation circuits	1	2	3	3	-	-	2	-	2	-	-	-
4	Able to operate and analyse the various types of power converter circuits with various types of loads	1	2	2	2	-	-	2	-	2	-	-	-
	1-Low, 2-Moderate, 3-High												

Course Title: Electrical Machines Lab -II			
Course Code:P15EEL58	**Semester: V**	**L-T-P-H(Hrs): 0-0-3-3**	**Credits – 1.5**
Contact period : Lecture: 36Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to:

1. They will be able to study OCC and load characteristics of DC generator & DC Motor
2. They will be able study the different methods of speed control of DC motor
3. They will be able to determine the efficiency of machine both as generator and motor by conducting various tests.
4. They will know the working of synchronous Motor

List of Experiments

1. a. OCC of DC shunt Generator
   b. Speed control of DC shunt motor
2. Load Characteristics of a DC Generators
3. Load test on DC shunt motor by Electrical Loading
4. Load test on DC motor using mechanical loading
5. Swinburne's test
6. Field test on DC series motor
7. Regulation of Alternator by EMF & MMF methods
8. Synchronization of alternator with the busbar
9. Slip test
10. V & Inverted V curves of synchronous motor
11. Self study experiment

Course outcomes

The course enable the students to:

CO1: Know about load characteristics of Dc generator and DC motor
CO2: Find the efficiency of motors by conducting various test as a motor and generator
CO3: Know about Synchronization of alternator with bus bar
CO4: Determine the regulation of an alternator by EMF& MMF methods
CO5: Study the characteristics of synchronous motor

Topic learning objective

1. Speed control of DC motor by Armature control method and field control method
2. Determine the efficiency of machine both as generator and motor by conducting various tests
3. Find the efficiency, BHP, Torque of a DC motor by Mechanical loading
4. Determining the regulation of an alternator by EMF & MMF methods
5. Synchronization of alternator with bus bar
6. Determining Xd and Xq by conducting slip test
7. Study of V & Inverted V curves of synchronous motor

Course Articulation Matrix (CAM)														
Course Outcome – CO			**Program Outcome** (ABET/NBA-(3a-k))											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Conduct different methods of speed control of DC motor	**L3**	L	M	M	M	-	-	-	-	-	-	-	M
2	Conduct Mechanical load test on different types of DC motor	**L3**	L	M	-	-	-	-	-	-	L	-	-	-
3	Find the efficiency of a machine as motor and generator	**L6**	L	L	M	M	-	M	-	-	-	-	-	-
4	Find the external and internal characteristics of a DC generator	**L4**	M	M	M	M	-	-	-	-	-	-	-	L
5	Discuss the various types of entrepreneur.	**L4**	L	M	M	M	-	-	-	-	-	-	-	M
	L-Low, M-Moderate, H-High													

Course assessment Matrix(CAM)														
Course Outcome - CO			**Program Outcome** (ABET/NBA-(3a-k))											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Describe the importance of management philosophy and the functional areas of management.	**L3**	1	2	2	2								2
2	Analyze the process of decision making	**L3**	1	2							1			
3	Understand the various types of organizations.	**L6**	1	1	2	2		2						
4	Analyze the importance of communication , techniques of co-ordination and sound controlsystem	**L4**	2	2	2	2								1
5	Discuss the various types of entrepreneur.	**L4**	1	2	2	2								2
	1-Low, 2-Moderate, 3-High													

Course Title : Aptitude and Reasoning Development - Advanced (ARDA)			
Course Code : P15HU510	**Semester : 5**	**L : T : P : H : 0 : 0 : 2 :2**	**Credits: 1**
Contact Period: Lecture: 32 Hr, Exam: 3 Hr		**Weightage: CIE:50;% SEE:50%**	

Prerequisites: Vocabulary builder, Concept of Percentage.

Course Learning Objectives (CLOs)

This course aims to

1. Describe the importance of reading with comprehension.
2. Explain seven dimensions approach to better reading skills.
3. Explain the purpose, plan and the ways to identify specific details in a paragraph for better comprehension.
4. Formulate easier ways to solve problems of averages.
5. Explain the Application of the technique of alligation while solving weighted average and mixture problems.
6. Describe the concepts of profit, loss, discount, Marked price.
7. Explain the application of percentage in our daily life.
8. Discover different ways to identify the progressions and to compare between AP< GP and HP.
9. Explain the basic concepts in calculating simple interest and compound interest.
10. Differentiate between simple interest and compound interest and describes the importance of compound interest and its behaviour.

Course Content

Unit – I

Reading Comprehension:

Introduction: Read more and more, The process of writing and its relevance to the process of writing, how reading skills are important for aspects other than the reading comprehension questions, the daily reading scheme.

Seven dimension approach to better reading skills:

Developing the ability of understanding vocabulary in context, Ability to identify and understand main ideas, Ability to predict and identify supporting details, Understanding the use of transition and idea organization patterns, Inferences, Identifying purpose and tone, Recognizing and evaluating arguments and their common structures.

Theory of reading comprehension :

Solving RC passages is an exact science, tackling RC on the basis of evaluation of support, All passages have a topic, purpose and a plan, Other things to pick up while reading the passage– The tonality and other software related the author's viewpoint in the passage, specific details and their use in the passage, Types of questions asked in reading comprehension passage.

10 hrs

Unit – II

Averages and Alligations mixtures:

Average: relevance of average, meaning of average, properties of average, deviation method, concept of weighted average. **Alligation method:** situation where allegation technique, general representation of alligations, the straight line approach, application of weighted average and alligation method in problems involving mixtures. Application of alligation on situation other than mixtures problems. **6 Hrs**

Unit – III

Profit and Loss: percentage change, original 100 concept effect of percentage increase or decrease in number, effect of successive percentage change, amount of change, comparison of two

numbers through percentage and ratio, return to original concept, net percentage change to keep product fixed. Definition of basic terms— cost price, selling price, profit percentage, discount and marked price, solving problems using n/d method, techniques to tackle from standard set of problems, the concept of mark up. Concept of partnership and problems involving partnership **6 Hrs**

Unit IV

Progression:

Arithmetic Progression: sum of given number of terms in an A.P., arithmetic mean, to insert a given number of arithmetic means between two given quantities, nth term of an A.P., finding common difference of an A.P. given 2 terms of an A.P., types of A.P.s– increasing A.P.s and decreasing A.P. s

Geometric: to find, the geometric mean between two given quantities, to insert a given number of geometric means between two given quantities, sum of a number of terms in a G.P. Types of G.P.s— increasing G. P. s type one and two , decreasing G. P. s type one and two.

Harmonic Progression: to find the harmonic mean between two given quantities , theorems related with progressions, solved examples sample company questions **6 Hrs**

Unit V

Simple Interest and Compound Interest

Concept of time value of money, Terminology pertaining to interest, Relation among Principal, Time, Rate percent per annum and total interest. Compound interest, Depreciation of value, Population, Application of interest in D.I.– The difference between simple annual growth rate and compound annual growth rate. **4 hrs**

Reference books:

1. The Trachtenberg speed system of basic mathematics, published by Rupa publications.
2. CAT Mathematics by Abhijith Guha. published by PHI learning private limited.
3. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal , published by S. Chand private limited.
5. Quantitative aptitude for CAT by Arun Sharma, published by McGraw Hill publication.

Course Outcomes (CO)

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

1. Apply the approach of seven dimension to better reading skills. L2
2. Solve the questions under reading comprehension confidently with higher accuracy than random reading. L4
3. Apply the technique of alligation for effective problem solving. L2
4. Interpret the requirement of different methods of calculating average and apply the right method at right scenario. L4
5. Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest. L5
6. Formulate the equations for summation and other functions for all the kinds of progressions– AP, GP and HP. L1

T L O

After learning all the topics of UNIT – I, the student is able to

1. Explain the importance of reading skills. L1
2. Interpret the importance of vocabulary in solving Reading comprehension questions. L4
3. Identify the main idea and supporting details in the paragraph. L2
4. Identify purpose and tone of the author.L2

5. Interpret the use of transition and idea organization pattern. L4
6. Recognize and evaluate arguments and their common structures. L1
7. Solve RC questions methodologically.L5
8. Classify types of questions asked in the RC passages. L2
9. Apply flow chart or mind map to solve RC questions. L4

After learning all the topics of UNIT – II, the student is able to

1. Analyze the properties of average and apply them in the right scenarios.L5
2. Apply the mean deviation method in certain set of questions. L2
3. Distinguish between the usage of simple average and weighted average.L1
4. Apply weighted average concept and formula to solve the problems of mixtures.L2
5. Compare the weighted average method with the alligation method and understand their strengths and limitations. L4
6. Apply the technique of alligation to solve problems in very less duration of time. L2
7. Understand the concept of homogeneity and other properties of mixtures. L4
8. Apply the basic properties of mixtures while solving the problems under the concept of removal and replacement. L2
9. Extend the application of alligation technique to solve the problems of other topics such as Profit and loss, time speed and distance, ratio and comparison etc. L6

After learning all the topics of UNIT – III, the student is able to

1. Define the meaning of basic terms such as Profit, loss, Profit percentage, Loss percentage. L1
2. Understand the meaning of Discount, Discount percentage, Marked price and mark up percentage and explain them. L4
3. Describe the importance of percentage in this chapter and combine the concepts of percentage to simplify the methodology of solving. L4
4. Apply n/d technique the solve the problems efficiently. L2
5. Apply the percentage fraction table for simplification.L2
6. Extend the application of n/d technique in other areas of aptitude where concept of product constancy is involved. L2
7. Solve the problems involving discount and discount percentage.L5
8. Formulate the mark up concept and apply it for better problem solving. L4
9. Apply the knowledge of Profit and loss, discount, discount percentage in day-to-day life.L2
10. Understand the factors to be considered during partnership and solve the solve the problems under partnership. L4

After learning all the topics of UNIT – IV, the student is able to

1. Interpret the series of numbers in Arithmetic, Geometric and Harmonic Progression. L1
2. Summarize the basic concepts of progressions, i.e., arithmetic mean, nth term of a progression. L6
3. Predict the missing terms of the given progression. L5
4. Compare AM, HM and GM. L4
5. Compute the sum or product of n terms in the given progression. L4
6. Differentiate between increasing and decreasing progression and solve application based problems accordingly. L1
7. Understand the theorems governing progressions. L4
8. Identify the similarity and difference between AP, HP and GP. L1
9. Analyze application problems involving combination of concepts of AP, HP and GP or all the three. L5
10. Create own problems based on creative progressive patterns and it’s combinations. L6
11. Solve problems based on average speed using concept of HP and AP. L6

After learning all the topics of UNIT – V, the student is able to

1. Recognize the concept of money and time, their relation and interdependency with respect to banking. L1

2. Outline the meaning of Principal, Time, Rate of Interest and Interest earned, and also their relation with one another. L1
3. Interpret the importance of CI in day to day life. L3
4. Illustrate the concept of Interest earned. L2
5. Distinguish between the types of interests.ie, Simple and Compound Interests.L4
6. Understand the difference between Simple and Compound annual growth.L4
7. Compute problems based on Simple Interests, Compound Interests and combination of both.L4
8. Solve application problems based on depreciation value, population of a city etc. L2
9. Apply various concepts of Percentages, Ratio, Algebra, HCF and LCM to solve application based problems. L2
10. Construct own questions involving multiple concepts ranging different difficult levels. L5
11. Solve MCQs faster by application of shortcut methods of Vedic Mathematics to find squares, cubes and roots. L5

A. Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcome (ABET/NBA-(3a-k))												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Apply the approach of seven dimension to better reading skills.	L2	-	-	-	-	-	-	-	-	M	-	-	-
Solve the questions under reading comprehension confidently with higher accuracy than random reading.	L4	-	-	-	-	-	-	M	-	M	-	-	-
Apply the technique of alligation for effective problem solving.	L2	H	-	-	-	-	-	-	-	-	-	-	-
Interpret the requirement of different methods of calculating average and apply the right method at right scenario.	L4	M	-	-	-	-	-	-	-	M	-	-	-
Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest.	L5	H	-	-	-	-	-	-	-	M	-	-	-

L- Low, M- Moderate, H-High

B. Course Assessment Matrix (CaM)

Course Outcome (CO)	Program Outcome (ABET/NBA-(3a-k))												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Apply the approach of seven dimension to better reading skills.	L2	-	-	-	-	-	-	-	-	2	-	-	-
Solve the questions under reading comprehension confidently with higher accuracy than random reading.	L4	-	-	-	-	-	-	2	-	2	-	-	-
Apply the technique of alligation for effective problem solving.	L2	3	-	-	-	-	-	-	-	-	-	-	-
Interpret the requirement of different methods of calculating average and apply the right method at right scenario.	L4	2	-	-	-	-	-	-	-	2	-	-	-
Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest.	L5	3	-	-	-	-	-	-	-	2	-	-	-
	1 – Low, 2 – Moderate and 3 – High												

VI SEMESTER

Course Title: Power System Analysis & Stability			
Course Code:P15EE61	**Semester: VI**	**L-T-P-H(Hrs): 4-0-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to

1. Develop the mathematical model for various types of power systems by using Single Line Diagrams (SLD) and per-unit impedance diagram.
2. Determine short-circuit currents for three-phase faults and design protective devices for various faults.
3. Utilize the concept of symmetrical components to determine the short-circuit currents and phase voltages for unbalanced faults.
4. Perform the calculation of 3-phase unsymmetrical faults.
5. Understand the concept of system stability by applying equal area criterion and by using swing equations &curve.

Course Content

Unit-I

Representation of Power System Components:
Circuit models - transmission line, synchronous machines, transformer and load. Single line diagram, Impedance and Reactance diagrams. Per unit system- merits and demerits, Per unit impedance/reactance diagrams of power systems, Illustrative examples. **10hrs**

Unit-II

Symmetrical Fault Analysis:
Transients on a transmission line, Short circuit currents and reactance of synchronous machines on no load, internal voltages of loaded machine under transient conditions, Selection of circuit breakers. Illustrative examples **10hrs**

Unit-III

Symmetrical Components:
Symmetrical components analysis of unbalanced phasors, Power in terms of symmetrical components, Phase shift of symmetrical components in star-delta transformer bank, Analysis of balanced and unbalanced loads against unbalanced three phase supplies, Sequence impedances and sequence networks, Sequence impedance of power system elements (alternator, transformer and transmission line), Positive, Negative and Zero sequence networks of power system elements. Illustrative examples. **10hrs**

Unit-IV

Unsymmetrical Faults: SLG/L-G, L-L, L-L-G/DLG faults on an unloaded alternator with and without fault impedances. Unsymmetrical faults on power system with and without fault impedances. Illustrative examples. Introduction to Open conductor faults in power systems (No numerical problems, only theory). **10hrs**

Unit-V

Stability Studies: Steady state and transient stability, Steady state and transient stability limits., Power angle equation, Concept of equal area criterion, Rotor dynamics and Swing equation, Illustrative examples. **10hrs**

Text Books:

1. W.D.Stevenson, “Elements of Power System Analysis”, MacGraw Hill, 4th Edition, 2013.
2. I. J. Nagarath and D.P.Kothari, “Modern Power System Analysis”, TMH, 4th Edition, 2013.

Reference Book:

1. Hadi Sadat, “Power system analysis”, TMH,2nd Edition, 2010

Course Outcomes

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

CO1: Model the Power System having the components viz., transformers, lines and generators and represent in a Single line diagram.

CO2: Analyze the given power system by using the per-unit Z-diagram

CO3: Analyze the three-phase faults and determine fault (short-circuit) currents.

CO4: By utilizing the symmetrical component techniques, determine short-circuit currents for different unsymmetrical faults.

CO5: Explain the stability problems and solve them.

Topic Learning Objectives (TLOs)

After learning all the topics of unit-I, the student is able to

1. Model power system components viz., transformers, transmission line, etc
2. Analysis of different reactances present in the synchronous machine
3. Drawing/construct the Single Line Diagram for any given power system
4. Differences between impedance and reactance diagram
5. Concept of Per Unit (p.u) representation
6. Drawing/develop the P.U Z- diagrams
7. Interpreting standard single line diagrams of practical systems

After learning all the topics of unit-II, the student is able to

1. Analysis of the various types of Short Circuit Faults
2. Concept short circuit reactances in alternators Understand the concept of neutral shift due to unbalanced loads
3. Distinguish the performances of power system with unbalanced supply from that of balanced load

After learning all the topics of unit-III, the student is able to

1. Analyze the transformation process of unbalanced phasors
2. Apply the symmetrical components techniques to power system analysis in various applications
3. Understand the operation of star-delta transformers and their effects
4. Determine the sequence impedances and its sequence impedance networks from the one-line diagram of the power system

After learning all the topics of unit-IV, the student is able to

1. Analyze the effect of different faults on the fault currents
2. Design of protection schemes for different faults
3. Application of fault analysis which includes false impedance

After learning all the topics of unit-V, the student is able to

1. Concept of stability in power systems
2. Distinguish between various kinds of stability
3. Use to solve problems on Swing equation
4. Application of equal area criterion to evaluate transient stability
5. Evaluate transient stability with different faults.

Review Questions

1. Explain the different power system elements with their mathematical models.
2. Define Per Unit value. What are the advantages of the P.U. system?
3. Explain how SLD are used to obtain the impedance diagrams
4. Prove that P.U. of transformer is same whether it is represented to primary or secondary.
5. Obtain the p.u. reactance diagram for the given typical power system.
6. Explain the oscillogram of the short circuit current of a alternator for three phase fault.
7. Define the transient, sub-transient and steady state reactances.
8. Explain how fault current is obtained from calculating the sub transient reactances and from the internal voltages

9. Explain how fault current is obtained by using Theviens equivalent circuits from the sub transient reactances and the internal voltages
10. Enumerate selection of various types of ratings of a circuit breaker
11. What are symmetrical components? Explain how the various sequence components are obtained for unbalanced supply
12. Obtain expression for power in terms of symmetrical components.
13. Explain with the help of neat vector diagrams, the phase shift of currents and voltages in case star – delta transformer.
14. Prove that balanced voltages produce the voltage drops of the same sequence only.
15. Draw the positive sequence, negative sequence and zero sequence network diagrams for the given typical power system network.
16. What are the various types of unsymmetrical faults which can occur in a generator? Explain briefly.
17. Derive the expressions for different fault current by obtaining the equivalent circuit for Single line to ground fault.
18. Derive the expression for the current and show the connections of sequences networks to represent the fault for two conductors open fault.
19. Draw the positive sequence, negative sequence and zero sequence network diagrams for the given typical power system network. Calculate the fault current , when double line ground fault occurs through fault impedance at the middle of the transmission line
20. What are the various types of unsymmetrical faults which can occur in a generator? Explain briefly.
21. Derive the expressions for different fault current by obtaining the equivalent circuit for Single line to ground fault.
22. Derive the expression for the current and show the connections of sequences networks to represent the fault for two conductors open fault.
23. Draw the positive sequence, negative sequence and zero sequence network diagrams for the given typical power system network. Calculate the fault current , when double line ground fault occurs through fault impedance at the middle of the transmission line.
24. What are the various types of unsymmetrical faults which can occur in a generator? Explain briefly.
25. Derive the expressions for different fault current by obtaining the equivalent circuit for Single line to ground fault.
26. Derive the expression for the current and show the connections of sequences networks to represent the fault for two conductors open fault.
27. Draw the positive sequence, negative sequence and zero sequence network diagrams for the given typical power system network. Calculate the fault current , when double line ground fault occurs through fault impedance at the middle of the transmission line.
28. Define stability, steady state stability, and transient stability.
29. Define steady state stability limit, and transient stability limit.
30. Derive the expression for power angle equation for the salient pole machine. Draw the power angle curve and indicate the stable operating point on the curve.
31. Derive the expression for the Swing equation with usual notations.
32. What are methods of improving transient stability?
33. What is Equal area criterion?
34. How is it use to study the stability of a power system?
35. Define Critical clearing angle and Critical clearing time.
36. Define steady state stability limit, and transient stability limit.
37. Derive the expression for power angle equation for the salient pole machine.
38. Draw the power angle curve and indicate the stable operating point on the curve.
39. Derive the expression for the Swing equation with usual notations.

40. Bring out the differences between power angle curve & swing curve. What information we get from these two curves?
41. Derive the expression for the maximum power transfer between two nodes. Show that it occurs at $X = \sqrt{3}.R$
42. What are methods of improving transient stability?
43. What is Equal area criterion (EAC)? Discuss any one of its applications.
44. How EAC is used to study the stability of a power system?
45. Define Critical clearing angle and Critical clearing time.
46. What are factors affecting the transient stability of a power system? Briefly explain

Lesson Plan

Unit-I

1. Introduction to power system and Power system networks.
2. Model of transmission line, Transformers
3. Different reactances of synchronous machines
4. Model of synchronous machine
5. Transformer model
6. Load model
7. One line diagram / Single line diagram representation
8. Per Unit (P.U) representation
9. Impedance and reactance diagram
10. Illustrative example

Unit-II

1. Transients on a transmission line
2. Short circuit currents and S.C current oscillogram
3. Reactances of synchronous machines on no load.
4. Internal voltages of loaded machine under transient conditions
5. Calculation of short circuit current
6. Three phase faults on power system calculations
7. Illustrative examples
8. Fault currents including pre-fault currents
9. Selection of circuit breakers.
10. Illustrative examples & Problems

Unit-III

1. Introduction to Symmetrical components and resolution of phasors into symmetrical components,
2. Unbalanced Analysis of balanced and unbalanced loads against unbalanced three phase supplies
3. Power in terms of symmetrical components
4. Phase shift in star-delta transformer
5. Power invariance of symmetrical components
6. Sequence impedances of generators, transformers and transmission lines
7. Positive, Negative and Zero Sequence networks
8. Sequence networks of power systems
9. Zero sequence network of different networks
10. Illustrative examples.

Unit-IV

1. Introduction to unsymmetrical faults. Unsymmetrical faults on power system
2. Single Line to Ground (SLG/LG) of an unloaded alternator without fault impedances. Illustrative examples
3. Line to line fault (L-L F) faults on an unloaded alternator without fault impedances. Illustrative examples

4. Double line to ground fault (L-L-G/DLG) faults on an unloaded alternator without fault impedances. Illustrative examples
5. SLG faults in power systems with fault impedances. Illustrative examples
6. L-L faults in power systems with fault impedances. Illustrative examples
7. DLG faults in power systems with fault impedances. Illustrative examples
8. Numerical Problems on unsymmetrical faults on power system with and without fault impedances. Illustrative examples
9. Introduction to Open conductor faults in power systems (No numerical problems, only theory)
10. Numerical Problems

Unit-V

1. Introduction to Steady state and transient stability
2. Steady state and transient stability limits
3. Power angle equations of Non- salient pole synchronous machines Illustrative examples
4. Power angle equations of salient pole synchronous machines. Illustrative examples
5. Steady state analysis and their limits (SSSL) in power systems
6. Transient stability - Rotor dynamics and Swing equation
7. Methods of improving stability. Illustrative examples
8. Equal area criterion for stability - theory
9. Equal area criterion for stability. Illustrative examples
10. Illustrative examples.

Course Articulation Matrix (CAM)

Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))												
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
6.	Modeling of the P.S components viz., transformers, lines and generators to represent in Single line diagram.	**L1**	H	M	M	-	M	-	-	-	-	L	M	H
7.	Analysis of a given power system using per-unit system.	**L2**	M	M	M	-	L	-	-	-	-	-	H	M
8.	Design and determining the performance of a Power system.	**L3**	H	L	M	-	H	-	-	-	-	-	M	H
9.	Analysis of short-circuit currents for three-phase faults.	**L4**	H	M	L	-	L	-	-	-	-	-	L	H
10	Utilizing symmetrical components to determine short-circuit currents, and phase voltages for unbalanced faults.	**L5**	M	M	H	-	L	-	-	-	-	-	L	M
L-Low, M-Moderate, H-High														

Course Assessment Matrix(CAM)

Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))												
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
6.	Modeling of the P.S components viz., transformers, lines and generators to represent in Single line diagram.	**L1**	3	2	2	-	2	-	-	-	-	1	2	3
7.	Analysis of a given power system using per-unit system.	**L2**	2	2	2	-	1	-	-	-	-	-	3	2
8.	Design and determining the performance of a Power system.	**L3**	3	1	2	-	3	-	-	-	-	-	2	3
9.	Analysis of short-circuit currents for three-phase faults.	**L4**	3	2	1	-	1	-	-	-	-	-	1	3
10	Utilizing symmetrical components to determine short-circuit currents, and phase voltages for unbalanced faults.	**L5**	2	2	3	-	1	-	-	-	-	-	1	2
1-Low, 2-Moderate, 3-High														

Course Title: Digital Signal Processing			
Course Code:P15EE62	**Semester: VI**	**L-T-P-H(Hrs): 3-2-0-5**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to:

1. Describe the concept of discrete-time Fourier transform (DFT) and its Inverse DFT (IDFT).
2. Analyze the discrete signals by using the different properties of DFT
3. Understand and use the FFT algorithms and its applications
4. Understand the general design and implementation of digital structures
5. Carry out the design and implementation of IIR filters and FIR filters

Course Content

Unit – I

Introduction to discrete Fourier transform (DFT) :

Introduction, Frequency domain sampling and reconstruction of discrete time signals, definitions of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier transform (IDFT). DFT as a linear transformation, DFT Relationship to z-transforms, DFT of standard signals, using the DFT to find the IDFT. **10hrs**

Unit – II

Properties of DFT:

Properties of DFT – Periodicity, Linearity, Circular Symmetries of a sequence. Symmetry properties of the DFT - real valued sequences, real & even sequences, real & odd sequences, purely imaginary sequences. Multiplication of two DFTs and circular convolution. Additional DFT properties – time reversal of sequences, circular time shift of a sequence, circular frequency shift, complex conjugate properties, multiplication of two sequences, Parsaval's theorem**..10hrs**

Unit – III

Fast Fourier Transform (FFT) :

Efficient computation of the DFT: FFT algorithms - Direct computation of DFT, Radix-2 algorithms - Decimation In Time and Frequency algorithms, Applications of FFT algorithms - Efficient computation of the DFTs of two real sequences (using a Single N-point DFT), Efficient computation of the DFTs of 2N point real sequences. **10hrs**

Unit – IV

Implementation of Discrete Time Systems :

Structures for realization of discrete time systems.

(a) Structures for IIR systems: direct form structure, signal flow graphs & transposed structures, cascade form structures, parallel form structures for IIR systems.

(b) Structures of FIR systems: direct form structure, cascade form structure, Linear phase structure. **10hrs**

Unit –V

Design of filters :

a) Design of Analog IIR filters – Analog Filter Specifications, classification of analog Filters, Butterworth analog filter, frequency/spectral transformations, design of Low pass (analog) Butterworth filters.

b) Digital filters: Design of IIR filters from analog filters -Bilinear transformation, Impulsive invariance transformation.

c) Design of FIR filters: Introduction, design of Linear phase FIR filter using windows. Windowing functions - rectangular window, Bartlett window, Hanning window, Hamming window, Blackman window **10hrs**

Text books:

1. Proakis, "Digital Signal Processing - Principle, Algorithms & Applications", 3rd edition, Pearson Education / PHI , 2013.
2. Dr. D Ganesh Rao&Vineeta P. Gejji , "Digital Signal Processing", Sanguine Technical Publishers, 2013.

Reference books:

1. J.S.Chitode , "Digital Signal Processing" - Technical publications. Pune. 2013

Course Outcomes

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

CO1: Apply the knowledge of DFT and IDFT to various discrete signals.

CO2: To analyze the discrete signals by using the different properties of DFT

CO3: Understand the FFT algorithms and apply FFT algorithms to find DFT

CO4: Understand the general design and implementation of different digital structure for digital systems

CO5:Carry out the design and implementation of IIR filters and FIR filters

Topic Learning Objectives

After learning all the topics of unit-I, the student is able to

1. Explain the frequency domain sampling and reconstruction of discrete time signals
2. Explain concept of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier transform (IDFT) for the frequency domain transformations
3. Perform or determine DFT/IDFT on various signals
4. Solve problems by matrix relations for computing DFT and IDFT

After learning all the topics of unit-II, the student is able to

1. Apply the knowledge of various properties of DFT
2. Apply Various Symmetry Properties
3. Determine DFT of real even and real odd sequences
4. Determine DFT of complex conjugate sequence
5. Explanation of Parsaval's theorem
6. Understanding *N*-point DFTs of two real sequences using a Single *N*-point DFT

After learning all the topics of unit-III, the student is able to

1. Explain the concept of Fast Fourier Transform (FFT)
2. Analyze -Decimation In Time(DIT) algorithm
3. Analyse - Decimation In Frequency (DIF) algorithm
4. Applications of FFT algorithms

After learning all the topics of unit-IV, the student is able to

1. Understanding digital structures
2. Analyze various Structures of FIR systems
3. Explain the structure of IIR systems
4. Analyze Structures for IIR systems
5. Solve problems based on FIR and IIR systems

After learning all the topics of unit-V, the student is able to

1. Analysis of analog filter specifications
2. Design of Low pass analog Butterworth filters
3. Design digital IIR filters from analog filters
4. Apply the frequency transformations

5. Design of digital filter by Impulsive invariance technique and bilinear transformation technique
6. Understanding FIR filter design
5. Compare various windowing techniques

Review Questions

1. What is the need of frequency domain sampling.
2. What is aliasing effect? Explain frequency domain sampling.
3. Give the definitions of DFT and IDFT.
4. Compute DFT of unit sample.
5. Find the N-point DFT of the given sequence x(t).
6. Show that the DFT and IDFT form a consistent discrete Fourier transform pairs.
7. Establish the relationship between z-transform and DFT
8. State properties of DFT
9. State and prove the following properties of the DFT. (i) Circular time reversal (ii) Circular time shift (iii) Circular frequency shift
10. Explain circular convolution
11. What is difference between circular convolution and Linear convolution.
12. Prove that the DFT of a real and even sequence is purely real and even.
13. Prove the time shifting property of DFT
14. In the direct computation of N-point DFT of a sequence, how many multiplications, additions and trigonometric function evaluation are required?
15. What is FFT?
16. Give the classification of various FFT algorithms
17. Explain radix -2 DIT-FFT algorithm. Explain how calculations are reduced.
18. Develop an 8-point DIT-FFT
19. Compare DIF-FFT algorithm with DIT-FFT algorithm
20. Use 8-point DIF-FFT radix- 2 algorithm to find the DFT of the given sequence x(n)
21. Write the short notes on the following: (i) Butterfly computation.(ii) Inplace computation (iii) bit reversal
22. Calculate the IDFT of the given X(k) , using inverse radix-2 DIT-FFT algorithm
23. Explain the implementation of FIR filters using direct form and cascaded form realizations.
24. Explain linear phase FIR structures. What are the advantages of such structures?
25. Realize a linear phase FIR filter with given impulse response h(n).
26. Realize the FIR filter (i) direct form (ii) Cascaded form for the given transfer function H(z).
27. Explain the Direct form-I and Direct form-II structure of IIR system
28. Obtain the cascade and parallel form for the given H(z).
29. What is transposed structure, explain with suitable example.
30. Compare the main features of analog and digital filters.
31. Explain the frequency transformations in analog domain
32. Explain the frequency transformations in digital domain
33. Explain in detail Butterworth filter approximation.
34. Explain the design of analog Butterworth low pass IIR filter.
35. Explain “impulse invariant technique” of designing digital –IIR filter with a relevant example.
36. Explain the bilinear transform method of IIR filter designing.
37. What is warping effect? Explain the poles and zeros mapping procedure clearly.
38. Compare impulse invariance and bilinear transformation methods.
39. Mention the properties of FIR digital filters. State their importance.

40. Derive the necessary conditions for FIR filters to have linear phase characteristics.
41. Compare various windows for the design of FIR filters.
42. Explain various types of windows used in the design of FIR filters. Write their analytical equations and draw the frequency response characteristics of each window

Lesson Plan

Unit-I

1. Introduction to Digital Signal Processing
2. Definition of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier transform (IDFT)
3. Different methods of calculating DFT
4. DFT of standard signals
5. DFT as a linear transformation – Matrix relations for computing DFT and IDFT
6. Problems based on DFT of different signals
7. Problems based on matrix method of DFT
8. Obtaining IDFT from DFT
9. Numerical Problems to determine IDFT
10. Solve the problems to find DFT/IDFT

Unit-II

1. Explanation of properties of DFT: Linearity, circular time shift and circular frequency shift
2. Symmetry Properties
3. DFT of real even and real odd sequences
4. DFT of complex conjugate sequence
5. Circular Convolution
6. Problems based on Circular Convolution
7. Time reversal of sequences, multiplication of two sequences
8. Parsaval's theorem.
9. *N*-point DFTs of two real sequences using a Single *N*-point DFT
10. Numerical Problems

Unit-III

1. Introduction to Fast Fourier Transform (FFT)
2. Explanation of Decimation In Time(DIT) algorithm
3. Explanation of Decimation In Frequency(DIF) algorithm
4. Problems using Decimation In Time(DIT) algorithm
5. Problems using Decimation In Time(DIT) algorithm
6. Problems using Decimation In Frequency (DIF) algorithm
7. Applications of FFT algorithms
8. Efficient computation of two real sequences & 2N real sequences
9. Problems based on FFT algorithms
10. Problems based on FFT algorithms

Unit-IV

1. Introduction to digital structures.
2. Structures of FIR systems: direct from structure, cascade structure, lattice structure.
3. Problems on FIR systems
4. Structures for IIR systems: direct form structure, signal flow graphs
5. Structures for IIR systems: transposed structures, cascade form
6. Structures for IIR systems: parallel form, lattice-ladder
7. Problems on IIR system for direct form structure, signal flow graphs
8. Problems on IIR system for transposed structures, cascade form
9. Problems on IIR system for transposed structures, cascade form
10. Problems on IIR system for parallel form, lattice-ladder. Illustrative examples

Unit-V

1. Introduction to IIR filter design. Analog filter specifications
2. Classification of analog filters - Butterworth filters
3. Frequency transformation/ spectral transformation
4. Design of Low pass analog Butterworth filters
5. Design of digital IIR filters from analog filters
6. Filter design by Impulsive invariance technique
7. Filter design by Bilinear transformation technique
8. Introduction to FIR filter design -Concept of Windowing techniques and its transfer function
9. Windowing functions - rectangular window, modified rectangular window, Hanning window, Hamming window, Blackman window, Kaiser Windows.
10. Illustrative examples

Course Articulation Matrix (CAM)

Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
11 Modeling of systems with difference equations and computing their solutions.	**L1**	H	M	H	-	H	-	-	-	-	-	H	H
12 Apply the knowledge of DFT and FFT in its various applications	**L2**	H	M	M	-	L	-	-	-	-	-	M	H
13 Transformation of digital signals into the frequency domain using FFT/DFT methods.	**L3**	M	M	L	-	L	-	-	-	-	-	M	M
14 Implementation or realization of different digital structures for IIR and FIR systems	**L4**	M	L	H	-	M	-	-	-	-	L	L	M
15 Design and Implementation of IIR filters using Bilinear Transformation	**L**	M	L	H	-	M	-	-		-	L	L	M
L-Low, M-Moderate, H-High													

Course Assessment Matrix(CAM)

Course Outcome – CO		**Program Outcome** (ABET/NBA-(3a-k))											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
11 Modeling of systems with difference equations and computing their solutions.	**L1**	3	2	3	-	3	-	-	-	-	-	3	3
12 Apply the knowledge of DFT and FFT in its various applications	**L2**	3	2	2	-	1	-	-	-	-	-	2	3
13 Transformation of digital signals into the frequency domain using FFT/DFT methods.	**L3**	2	2	1	-	1	-	-	-	-	-	2	2
14 Implementation or realization of different digital structures for IIR and FIR systems	**L4**	2	1	3	-	2	-	-	-	-	1	1	2
15 Design and Implementation of IIR filters using Bilinear Transformation	**L5**	2	1	3	-	2	-	-		-	1	1	2
1-Low, 2-Moderate, 3-High													

Course Title: Electrical Machine Design			
Course Code:P15EE63	**Semester: VI**	**L-T-P-H(Hrs): 3-1-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to:

1. Different types of conducting, magnetic and insulating materials used in electrical machines.
2. Design of D.C. Machines.
3. Design of Transformers.
4. Design of Induction machines.
5. Design of Synchronous machines

Course Content

Unit – I

PRINCIPLES OF ELECTRICAL MACHINE DESIGN: Introduction, Considerations for the design of electrical machines, Limitations. Different types of materials used in electrical machines.

Design of machines: Output equation of a DC machine, Choice of specific loadings and choice of number of poles in a DC machines, Design of Main dimensions of the DC machines. **10hrs**

Unit – II

DESIGN OF DC MACHINES:, Design of armature slot dimensions, Commutator and brushes. Magnetic circuit- estimation of ampere turns, Design of yoke and pole, Field windings-shunt & series. **10hrs**

Unit – III

DESIGN OF TRANSFORMERS: Output equation for single phase and three phase transformer, Choice of specific loadings, Expression for volts/turn, Determination of main dimensions of the core, Types of windings and estimation of number of turns and cross sectional area of primary and secondary coils, Estimation of no load current, Design of tank and cooling tubes (round and rectangular), dry type transformers. **10hrs**

Unit – IV

DESIGN OF INDUCTION MOTORS: Output equation, Choice of specific loadings, Main dimensions of three phase induction motor, Stator winding design, Choice of length of the air gap, Estimation of number of slots for the squirrel cage rotor (Excluding design of Slip ring induction motor), Design of Rotor bars and end rotor. **10hrs**

Unit – V

DESIGN OF SYNCHRONOUS MACHINES: Output equation, Choice of specific loadings, Short circuit ratio, design of main dimensions, Armature slots and windings, Slot details for the stator of salient and non-salient pole synchronous machines. Design of rotor of salient pole synchronous machines, Magnetic circuits, Design of the field winding. **10hrs**

TEXT BOOKS:

1. A.K.Sawhney, **"**A Course In Electrical Machine Design **"**-6th edition, Dhanapathrai& co, Delhi
2. V.N. Mittle, Design of Electrical Machines **—** 4th edition, standard publishers, New Delhi

REFERENCE BOOKS:

M.G Say,Performance& Design of AC Machines - CBS Publishers

Course Outcomes

After learning all the units of the course,

CO1: The students are familiarized with different types of conducting, magnetic and insulating materials used in electrical machines.

CO2: The students will be able to Design different parts of D.C. Machines.

CO3: The students will be able to Design sign of different parts of transformer.

CO4: The students will be able to Design of a different parts of Induction motors.

CO5: The students are familiarized with Design of different parts of Synchronous machines

Topic learning objective

After learning all the topics of unit – I the student is able to

1. Know Considerations for the design of electrical machines, Limitations.
2. Different types of materials used in electrical machines.
3. Classification of Insulating Materials.
4. Derivation of Output Equation
5. Problems on output Equation
6. Problems on output Equation
7. Choice of specific loadings and choice of number of poles.
8. Problems on choice of specific loadings and choice of number of poles
9. Problems on choice of specific loadings and choice of number of poles
10. Problems on choice of specific loadings and choice of number of poles

After learning all the topics of unit – II the student is able to

1. Design of Main dimensions of the DC machines.
2. Problems on Main dimensions of the DC machines
3. Design of armature slot dimensions.
4. Problems on armature slot dimensions
5. Commutator and brushes
6. Magnetic circuit- estimation of ampere turns
7. Problems on Magnetic circuit- estimation of ampere turns
8. Design of yoke and pole, Field windings-shunt & series.
9. Problems on yoke and pole, Field windings-shunt & series
10. Problems on yoke and pole, Field windings-shunt & series

After learning all the topics of unit – III the student is able to

1. **(**Single phase and three phases):Derive Output equation for single phase and three phase transformer.
2. Problems on Output equation for single phase and three phase transformer.
3. Choice of specific loadings, Expression for volts/turn.
4. Determination of main dimensions of the core.
5. Problems on dimensions of the core
6. Types of windings and estimation of number of turns and cross sectional area of primary and secondary coils.
7. Estimation of no load current
8. Design of tank and cooling tubes (round and rectangular) .
9. Problems on Design of tank and cooling tubes
10. Problems on Design of tank and cooling tubes

After learning all the topics of unit – IV the student is able to

1. Derive Output equation, Choice of specific loadings
2. Problems on Output equation, Choice of specific loadings
3. Main dimensions of three phase induction motor.
4. Problems on Main dimensions of three phase induction motor
5. design Stator winding
6. Problems on stator winding design, Choice of length of the air gap

7. Estimation of number of slots for the squirrel cage rotor
8. Problems on Estimation of number of slots for the squirrel cage rotor
9. Design of Rotor bars and end ring
10. Problems on Design of Rotor bars and end ring

After learning all the topics of unit – V the student is able to

1. Derive Output equation, Choice of specific loadings.
2. Short circuit ratio, design of main dimensions.
3. Problems on Short circuit ratio, design of main dimensions
4. Problems on Short circuit ratio, design of main dimensions
5. Armature slots and windings, Slot details for the stator of salient and non-salient pole synchronous machines.
6. Problems on Armature slots and windings, Slot
7. Problems on Armature slots and windings, Slot
8. Design of rotor of salient pole Synchronous machines, Magnetic circuits.
9. Design of the field winding
10. Problems on Design of the field winding

Review Questions

1. Derive output equation for a DC machine. Mention merits & de-merits of choosing higher values for specific loadings.
2. Discuss the choice of number of poles used in DC machines.
3. Explain the procedure for designing a shunt field coil for a DC machine.
4. Explain different types of magnetic materials.
5. Explain different types of insulating materials.
6. Explain the factor on which the specific electric loading depends in the case of DC machines.
7. Explain the various factors that affect the choice of number of poles of a DC machine.
8. Explain the procedure for design of field winding in a DC machine.
9. Define specific electrical & magnetic loadings for DC machines. Derive the output equation for DC machine. Explain in brief the factors to be considered during choice of specific loadings.
10. Discuss the choice of specific magnetic loading & specific electric loading.
11. Explain the factors affecting choice of average flux density & ampere conductors per meter.
12. What are the points to be considered for fixing up dimension of armature slot.
13. Explain the design of brushes in details.
14. Classify insulating materials in electrical machines based on thermal considerations.
15. Explain clearly the factors which impose limitations in the design of electrical machines.
16. Prove that emf/turn of a single phase transformer=K$\sqrt{Q}$ where Q=per phase kVA output of transformer.
17. Derive an expression for leakage reactance of a transformer with primary & secondary cylindrical coils of equal length, stating clearly the assumptions made.
18. Derive output equation for 3-ph core type transformer.
19. Explain the calculation no-load current components of a transformer.
20. What are the different types of transformer windings? & explain any one.
21. Why a transformer does has stepped & laminated core.
22. Derive output equation for a 3-ph transformer and deduce the same for two winding transformer.
23. Show that
24. For minimum cost design of transformer, cost of iron = cost of conductor.

25. For minimum Cu loss, current density in primary winding = current density in secondary winding.
26. Explain different methods of cooling of transformer.
27. Discuss design of transformer tank with tubes.
28. Derive an expression for leakage reactance of a sandwich coil.
29. Explain continuous disc type winding.
30. Derive an expression for output equation of IM with symbolic notations.
31. Explain the considerations for the selection of specific electric & magnetic loading.
32. Explain cogging in induction motor.
33. Explain crawling in induction motor.
34. What are the factors to be considered for selection of stator slots? & explain them.
35. Explain choice of average flux density in air gap, & choice of ampere conductors/meter.
36. What are the factors to be considered for estimating length of air gap?
37. What are the empirical formulas for calculating length of air gap?
38. Write a note on end ring current.
39. Write a note on number of rotor slots of squirrel cage induction motor.
40. Write a note on stator winding design of 3-ph induction motor.
41. What are the point to be considered for the selections of number of stators slots in IM
42. Define the short circuit ratio in connection with 3 phase synchronous generator. Explain the factors affected by SCR.
43. Discuss the factors to be considered while selecting the length of air gap, number of stator & rotor slots.
44. Explain the various factors considered for the selection of armature slots of a 3 phase synchronous machine.
45. Derive an output equation for a 3 phase Synchronous machine.
46. Explain the choice of specific electric loading & specific magnetic loading.
47. Explain design of rotor of non-salient synchronous machine.
48. Explain the advantages of rotating field structure.
49. Explain the factors to be considered for the selection of number of armature slots in an alternator.
50. What are the procedural steps involved in rotor design of turbo alternator

Lesson Plan

Unit – I

1. Introduction, Considerations for the design of electrical machines, Limitations.
2. Different types of materials and insulations used in electrical machines.
3. Derivation of Output Equation
4. Problems on output Equation
5. Problems on output Equation
6. Choice of specific loadings and choice of number of poles.
7. Problems on choice of specific loadings and choice of number of poles
8. Problems on choice of specific loadings and choice of number of poles
9. Problems on choice of specific loadings and choice of number of poles
10. Problems on choice of specific loadings and choice of number of poles

Unit – II

1. Design of Main dimensions of the DC machines.
2. Problems on Main dimensions of the DC machines
3. Design of armature slot dimensions.
4. Problems on armature slot dimensions
5. Commutator and brushes
6. Magnetic circuit- estimation of ampere turns
7. Problems on Magnetic circuit- estimation of ampere turns

8. Design of yoke and pole, Field windings-shunt & series.
9. Problems on yoke and pole, Field windings-shunt & series
10. Problems on yoke and pole, Field windings-shunt & series

Unit – III

1. **(**Single phase and three phases**)**: Output equation for single phase and three phase transformer.
2. Problems on Output equation for single phase and three phase transformer.
3. Choice of specific loadings, Expression for volts/turn.
4. Determination of main dimensions of the core.
5. Problems on dimensions of the core
6. Types of windings and estimation of number of turns and cross sectional area of primary and secondary coils.
7. Estimation of no load current
8. Design of tank and cooling tubes (round and rectangular) .
9. Problems on Design of tank and cooling tubes
10. Problems on Design of tank and cooling tubes

Unit – IV

1. Output equation, Choice of specific loadings
2. Problems on Output equation, Choice of specific loadings
3. Main dimensions of three phase induction motor.
4. Problems on Main dimensions of three phase induction motor
5. Stator winding design
6. Problems on stator winding design, Choice of length of the air gap
7. Estimation of number of slots for the squirrel cage rotor
8. Problems on Estimation of number of slots for the squirrel cage rotor
9. Design of Rotor bars and end ring
10. Problems on Design of Rotor bars and end ring

Unit – V

1. Output equation, Choice of specific loadings.
2. Short circuit ratio, design of main dimensions.
3. Problems on Short circuit ratio, design of main dimensions
4. Problems on Short circuit ratio, design of main dimensions
5. Armature slots and windings, Slot details for the stator of salient and non-salient pole synchronous machines.
6. Problems on Armature slots and windings, Slot
7. Problems on Armature slots and windings, Slot
8. Design of rotor of salient pole Synchronous machines, Magnetic circuits.
9. Design of the field winding
10. Problems on Design of the field winding

Course Articulation Matrix (CAM)													
Course Outcome – CO			**Program Outcome** (ABET/NBA-(3a-k))										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	The students are familiarized with different types of conducting magnetic and insulating materials used in electrical machines	**L4**	H	H			H		M		M		L	
2	The students will be able to Design different parts of D.C. Machines.	**L2**	H	M			H		M		M		M	
3	The students will be able to Design different parts of transformer.	**L6**	H	M					M		M			
4	The students will be able to Design a different parts of Induction motors.	**L5**	H	M					H		M		M	
5	The students are familiarized with Design of different parts of Synchronous machines.	**L1**	H	H			L		M		M		L	
	1-Low, 2-Moderate, 3-High													

Course assessment Matrix(CAM)													
Course Outcome - CO			**Program Outcome** (ABET/NBA-(3a-k))										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	The students are familiarized with different types of conducting magnetic and insulating materials used in electrical machines	**L4**	3	3			3		2		2		1	
2	The students will be able to Design different parts of D.C. Machines.	**L2**	3	2			3		2		2		2	
3	The students will be able to Design different parts of transformer.	**L6**	3	2					2		2			
4	The students will be able to Design a different parts of Induction motors.	**L5**	3	2					3		2		2	
5	The students are familiarized with Design of different parts of Synchronous machines.	**L1**	3	3			1		2		2		1	
	1-Low, 2-Moderate, 3-High													

Course Title: Switchgear and Protection			
Course Code:P15EE64	**Semester: VI**	**L-T-P-H(Hrs): 4-0-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to:

1. Identify the characteristics of fuse, switches and types of Circuit breakers and relays
2. Study the operation principles of circuit breakers and its arc extinction
3. Study the operation principles of protective relays and its selection criteria
4. Study the different protection scheme for Generator, Transformers and Induction motors
5. Introduce students to power system protection and switchgear

Course content

Unit-I

SWITCHES AND FUSES:

Isolating switch, Load breaking switch, Fuse law, Cut -off characteristics, : Time- current characteristics, Fuse material, HRC fuse, Liquid fuse, Application of fuse .

PRINCIPLES OF CIRCUIT BREAKERS: Principles of AC circuit breaking, Principles of DC circuit breaking, Problems encountered in DC breaking, Initiation & maintenance of arc, Arc interruption – high resistance and low resistance interruption, Arc interruption theories – slepian's theory and energy balance theory, Re-striking voltage, Recovery voltage, Rate of rise of Re-striking voltage, Current chopping, Capacitance switching, Resistance switching. **10hrs**

Unit-II

CIRCUIT BREAKERS:

Air Circuit breakers – air break and air blast circuit breakers, SF_6breaker - preparation of SF_6 gas, puffer and non puffer type of SF_6 breakers, Gas Insulated Circuit breaker, Nitrogen Fire extinguisher, Miniature circuit breaker (MCB), Earth leakage circuit breaker (ELCB).

Vacuum circuit breakers - Construction, Principle of operation, Advantages and disadvantages of different types of circuit breakers, Rating of circuit breakers Testing of circuit breakers - unit testing, synthetic testing ; Short circuit test lay out. **10hrs**

Unit-III

PROTECTIVE RELAYING:

Requirement of protective relaying, Zones of protection, Primary and backup protection, Essential qualities of protective relaying, Classification of protective relays

INDUCTION TYPE RELAY:

Non-directional and directional over current relays, IDMT and Directional characteristics. Differential relay – principle of operation, percentage differential relay, bias characteristics, Distance relay – three stepped distance protection ; Impedance relay, Reactance relay, Mho relay,

10hrs

Unit-IV

PROTECTION SCHEMES:

Generator Protection - Merz price protection, prime mover faults, stator and rotor faults; Protection against abnormal conditions – unbalanced loading, loss of excitation, over speeding, Negative Sequence relay. **10hrs**

Unit-V

Transformer Protection – Introduction, Possible transformer faults, differential protection, Merz-prize protection, Buchholz relay, harmonic restraint, Frame leakage protection.

Induction motor protection – protection against electrical faults such as phase fault and ground fault, Abnormal operating conditions such as single phasing, phase reversal and over load.

10Hrs

TEXT BOOKS:

1. **Switchgear & Protection**- Sunil S.Rao, Khanna Publishers. 13th edition, 2013

2. **Power System Protection & Switchgear 2nd Edition**- Badriram&Viswakarma, McGraw-Hill Education-2011 .

REFERENCE BOOKS:

1.Power System Protection & Switchgear- Ravindarnath & Chandra,2014, New age Publications.

Course Outcomes

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

CO1: Select a fuse and/or a circuit breaker for a given application.

CO2: Distinguish between various types of circuit breakers and analyze the operation principles of circuit breakers and its arc extinction.

CO3: Compare the characteristic of different relays and selection criteria

CO4: Understand and analyze the different protection scheme for Generator

CO5: Understand and analyze the different protection scheme for Transformers and Induction motors.

Topic Learning Objectives

After learning all the topics of unit-I, the student is able to

1. Understand the basic concepts of Fuse, Switches and its characteristics
2. Explain the construction and operation of different switches
3. Explain the different methods of arc extinction
4. Explain the concept of current chopping and resistance switching

After learning all the topics of unit-II, the student is able to

1. Explain the concept of circuit breaker
2. Explain the different types of circuit breaker with respect to arc extinction media
3. Explain the construction and operation of different circuit breaker
4. Compare the different methods of circuit breaker with their advantage and disadvantages
5. Implement different testing of circuit breaker

After learning all the topics of unit-III, the student is able to

1. Describe the protective relay and its qualities
2. Describe the zones of protection, primary and backup protection
3. Explain the construction and operation of different types of relay
4. Use of different relays for specific protection

After learning all the topics of unit-IV, the student is able to

1. Describe different faults which are generally occur in Generator
2. Explain the different protection scheme for generator
3. Explain the concept of Stator and Rotor protection
4. Explain the concept different relay to protect generator

After learning all the topics of unit-V, the student is able to

1. Explain different possible faults which are occur in transformer
2. Explain the different protection scheme for Transformer
3. Explain the concept of buchholz relay
4. Explain the abnormal conditions and failure in case of induction motor
5. Explain the protection scheme for induction motor

Review Questions

1. What is switch gear? What is its function
2. Define current rating of fuse, Fusing current, Fusing factor
3. Write a note on load breaking switch
4. Explain the construction and operation of HRC fuse
5. Explain the construction and operation of Liquid fuse
6. Define circuit breaker , Describe its operation in brief
7. Explain the following : \arc voltage, Restriking voltage, Recovery voltage
8. What are the different types circuit breaker when the arc quenching medium is the criteria
9. What are different arc interruption methods ? Explain in brief
10. Explain how current interruption takes place in an AC circuit breaker
11. Derive the expression for 'R' critical in terms of system inductance and capacitance
12. Explain the slepian's theory and Cassies theory

13. Write a note on interruption of capacitive currents
14. Explain the construction and working of air break circuit breaker
15. Explain the construction and working of air blast circuit breaker
16. Explain the construction and working of oil circuit breaker
17. Explain the construction and working of SF6 circuit breaker
18. Explain the construction and working of vacuum circuit breaker
19. What are the possible applications in of vacuum circuit breaker
20. Write a note on unit testing and Synthetic testing
21. Describe short circuit test layout of circuit breaker
22. Mention the properties of SF6 circuit breakers
23. Enumerate various types of ratings of a circuit breaker
24. What are the different methods of testing of circuit breaker ? Discuss their merits and demerits
25. What is protective relay ? Explain the various functions of protective relay
26. Explain the essential qualities of protective relay
27. What is protective zone with the help of diagram, show the various zones of protection in typical power system
28. Explain what is meant by primary protection and backup protection
29. Explain with the help of neat sketches, the construction and working of directional induction type over current relay
30. Explain how an impedance relay is used for distance protection
31. Explain the working of percentage differential relay
32. Explain how an impedance relay is used for distance protection obtain its operating characteristics
33. State the advantages and application of distance relay
34. Explain the three stepped distance protection of transmission line
35. Draw and explain the block diagram of microprocessor based relay
36. Which are the various types of faults which can occur in a generator ? Explain in brief
37. Explain the basic differential protection scheme. What are its advantages
38. Draw and explain balanced earth fault protection scheme
39. How the protection against loss of excitation is provided in generator
40. Explain the restricted earth fault protection of generator
41. Explain the negative phase sequence protection for the generator
42. What are the methods to provide rotor earth fault protection
43. State and explain the various possible faults in transformer
44. Draw and explain the Merz-price protection scheme for Star-delta and Star-Star transformer
45. Explain the construction and working of buchholz relay
46. Explain the abnormal conditions and possible failure of induction motor
47. Which type of protection is selected for various abnormal conditions
48. Explain over load protection in case of induction motors
49. Explain single phasing in induction motor. How motor is protected from single phasing
50. What phase reversal? What is its effect? How it prevented in induction motor

Lesson Plan

Unit-I

1. Isolating switch, Load breaking switch
2. Fuse law, Cut -off characteristics
3. Time- current characteristics, Fuse material, HRC fuse
4. Liquid fuse, Application of fuse
5. Principles of AC circuit breaking, Principles of DC circuit breaking
6. Initiation & maintenance of arc, Arc interruption – high resistance
7. low resistance interruption, Arc interruption theories – slepian's theory and energy balance theory
8. Re-striking voltage, Recovery voltage, Rate of rise of Re-striking voltage
9. Current chopping, Capacitance switching

10. Resistance switching, Rating of circuit breakers

Unit-II

1. Air break circuit breaker
2. Air blast circuit breakers
3. Oil circuit breakers
4. Single break, Double break
5. Minimum OCB
6. SF_6 breaker and its properties
7. Puffer and non puffer type of SF_6 breakers
8. Vacuum circuit breakers :Construction, Principle of operation
9. Advantages and disadvantages of different types of circuit breakers
10. Testing of circuit breakers - unit testing, synthetic testing ; Short circuit test lay out.

Unit-III

1. Introduction to relay, requirement of protective relaying
2. Zones of protection, Primary and backup protection
3. Essential qualities of protective relaying
4. Classification of protective relays
5. Non-directional and directional over current relays
6. IDMT and Directional characteristics
7. Differential relay – principle of operation, percentage differential relay, bias characteristics
8. Distance relay – three stepped distance protection
9. Impedance relay
10. Reactance relay, Mhorelay

Unit-IV

1. Merz price protection
2. prime mover faults
3. Stator faults
4. Rotor faults
5. Protection against abnormal conditions
6. Unbalanced loading
7. Loss of excitation
8. Over speeding
9. Negative Sequence relay.
10. Numerical Problems

Unit-V

1. Introduction to Transformer Protection
2. Buchholz relay
3. Differential protection
4. Differential relay with harmonic restraint, inter turn faults,
5. Inter turn faults
6. Numerical problems
7. Induction motor protection – protection against electrical faults
8. phase fault and ground fault,
9. Abnormal operating conditions such as single phasing
10. Phase reversal and over load.

Course Articulation Matrix (CAM)													
Course Outcome – CO			**Program Outcome** (ABET/NBA-(3a-k))										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Select a fuse and/or a circuit breaker for a given application.	**L4**	H	M	L	-	-	-	-	-	-	-	-	-
2	Distinguish between various types of circuit breakers and analyze the operation principles of circuit breakers and its arc extinction.	**L2**	L	M	H	-	L	-	-	-	-	-	-	-
3	Compare the characteristic of different relays and selection criteria	**L6**	H	M	H	-	-	-	-	-	-	-	L	-
4	Understand and analyze the different protection scheme for Generator	**L5**	H	M	L	-	L	-	-	-	-	-	L	-
5	Understand and analyze the different protection scheme for Transformers and Induction motors.	**L1**	L	M	H	-	L	-	-	-	-	-	L	-
	L-Low, M-Moderate, H-High													

Course assessment Matrix(CAM)													
Course Outcome - CO			**Program Outcome** (ABET/NBA-(3a-k))										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Select a fuse and/or a circuit breaker for a given application.	**L4**	3	2	1									
2	Distinguish between various types of circuit breakers and analyze the operation principles of circuit breakers and its arc extinction.	**L2**	1	2	3		1							
3	Compare the characteristic of different relays and selection criteria	**L6**	3	2	3								1	
4	Understand and analyze the different protection scheme for Generator	**L5**	3	2	1		1						1	
5	Understand and analyze the different protection scheme for Transformers and Induction motors.	**L1**	1	2	3		1						1	
	1-Low, 2-Moderate, 3-High													

Course Title: Modern Control Theory			
Course Code:P15EE651	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

Unit – I

Industrial Automatic controllers: - Two position/ on-off control, Proportional (P) controller, Integral (I) controller, Proportional- Integral (PI) controller, Proportional -Differential (PD) controller, Proportional –Integral – Differential (PID) controller. Effects of the PID controller on the second order system performance, realization of PI, PD and PID controllers.

Compensation techniques:-Introduction, Classification of compensation, compensation networks, lead compensator, lag compensator and lag-lead compensators, Effects and limitations of compensators**.** (Design Problems are excluded) **10hrs**

Unit – II

Modeling in state space: Introduction, Limitations of classical control theory, Concept of State, State variables, State vector, State space, State-space equations and block diagram of the linear, continuous –time control system represented in state space, State space model for physical systems-electrical, mechanical and electro mechanical systems, linearization of state equation.

State space representations of transfer function systems: Canonical forms- Controllable, observable, diagonal, Jordan canonical forms, Eigen values, diagonalisation, invariance of Eigen values. **10hrs**

Unit – III

Solution of the linear time invariant state equation: state transition matrix –properties, computation using Laplace transformation, power series, modal matrix & Cayley- Hamilton method, solution of homogeneous and non-homogenous state equations.

Concept of Controllability & Observability - Kalman's test and Gilbert's test, complete controllability & observability in the s-plane, Stabilizability and Detectability, Principle of Duality **10hrs**

Unit – IV

Design of control systems in state space; Design by Pole Placement technique, stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, computation of feedback gain matrix by direct substitution, Ackermann's formula, and design of full order state observer. **10hrs**

Unit –V

Liapunov stability analysis: Equilibrium state, Stability in the sense of Liapunov, Asymptotic stability, asymptotic stability in the large, instability and its graphical representation. Sign definiteness of scalar functions, Liapunov's function, and Liapunov stability analysis of linear, time invariant systems. Construction of Liapunov functions for nonlinear system by Krasovskii's method **10hrs**

Text Books:

1. KatshuikoOgata"Modern Control Engineering", - 3rdedition 2002 & 5th Edition, 2012, PHI.
2. I. J Nagrath& M. Gopal,"Control Systems Engineering", New Age International Publishers, 5th Edition 2010.

Reference Books:

1. M Gopal"Digital Control & State variable methods", 3rd edition, TMH

Course Title: Advanced Power Electronics			
Course Code:P15EE652	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course content

Unit-I

DC-DC Switched Mode Converters: Topologies, Buck, Boost, Buck-Boost, and Cuk converters, Full Bridge DC-DC converter-detailed theory, Working principles, Modes of operation, With detailed circuits and wave forms, Applications, Merits and demerits **12Hrs**

Unit-II

DC-AC switched mode inverters: Single-phase inverter, Three phase inverters. SPWM inverter, Detailed theory, Working principles, Modes of operation with circuit analysis, Applications, Merits and demerits, Problems based on input output voltage relationship, effect of blanking time on o/p voltage. **10Hrs**

Unit-III

Resonant converters: Introduction, series and parallel resonant inverters, Zero voltage and zero current switching, Resonant switch converters, Comparison with hard switching, zero voltage switching with clamping, resonant DC link inverter with zero voltage switching. **10Hrs**

Unit-IV

Power Supplies: Introduction, DC power supplies: fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter, AC power supplies: switched mode ac power supplies, resonant ac power supplies, bidirectional ac power supplies ,Multistage conversions, Power factor conditioning. **10Hrs**

Unit-V

High frequency inductor and transformers: Introduction, Design steps, Detail Design of Inductors and Transformers. **10Hrs**

TEXT BOOKS:

1. **Power Electronics-** converters, application & design- Mohan N, Undeland T.M., Robins, W.P-John Wiley 1989
2. **Power Electronics-Circuits, Devices,** Applications- Rashid M.H.-3rd Edition, Prentice Hall India, 2008.

REFERENCE:

1. **Power Electronics and A.C. Drives-** Bose B.K.-Prentice Hall 1986.
2. **Digital Power Electronics And Applications-** Muhammad Rashid. first edition, 2005, Elsevier.

Course Title: Embedded Systems			
Course Code:P15EE653	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course content

UNIT-I

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-II

General Purpose Processor: Introduction, Basic Architecture, Operation, Programmer's View, Development Environment, Application-Specific Instruction-Set Processors (ASIPs), Selecting a Microprocessor, General-Purpose Processor Design

Standard Single-Purpose Processors: Peripherals, Introduction, Timers, Counters, and Watchdog Timers, Timers and Counters, Watchdog Timers, UART, Pulse Width Modulators, LCD Controllers, Keypad Controllers, Stepper Motor Controllers, Analog-to-Digital Converters, Real-Time Clocks **10 Hrs**

UNIT-III

Memory: Introduction, Memory Write Ability and Storage Permanence, Memory Types, ROM, Mask-Programmed ROM, OTP ROM, EPROM, EEPROM, Flash Memory, Read-Write Memory **—** RAM, SRAM,DRAM, PSRAM, NVRAM, Composing Memory, Memory Hierarchy and Cache, Advanced RAM, various DRAMs, DRAM Integration Problem, Memory Management Unit (MMU)

Interfacing: Introduction, Communication Basics, Microprocessor Interfacing: I/O Addressing, Interrupts, DMA, Advanced Communication Principles, Serial Protocols, Parallel Protocols, Wireless Protocols (Excluding: Arbitration) **10 Hrs**

UNIT-IV

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-V

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, 2015
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, 2014

Reference Books:

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

Course Title: Operating System			
Course Code:P15EE654	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course content

Unit – I

Introduction to operating systems

Overview: Need of operating systems, Computer System organization, Computer System architecture, Operating System structure, Operating System operations, Process management, Memory management, Storage management, Protection and security, Distributed system, computing environments.

System structure: Operating System Services, User- Operating System interface, System calls, Types of system calls, System programs, Operating System design and implementation, Operating System structure, Virtual machines, System boot. **10 Hrs**

Unit – II

Process management

Process concepts: Overview, Process scheduling, operations on processes, Inter-process communication.

Multi-Threaded Programming: Overview, Multi-threading models, Thread Libraries, threading issues.

Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple-Processor scheduling, thread scheduling **11 Hrs**

Unit – III

Process synchronization

Synchronization: Background, The Critical section problem, Peterson's solution, Synchronization hardware, Semaphores, Classical problems of synchronization, Monitors

Deadlocks: System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection and recovery from deadlock **10 Hrs**

Unit – IV

Memory and i/o management

Memory Management Strategies: Background, Swapping, Contiguous memory allocation, Paging, Structure of page table, Segmentation.

Virtual Memory Management: Background, Demand paging, Copy-on-write, Page replacement, Allocation of frames, Thrashing.

I/O Systems: Overview, I/O hardware, Application I/O interface, STREAMS. **11 Hrs**

Unit – V

Storage management and protection

File system: File concept, Access methods, Directory structure, File system mounting, File sharing, Protection.

Implementing File System: File system structure, File system implementation, Directory implementation, Allocation methods, Free space management.

Secondary storage structures: Mass storage structures, Disk structure, Disk attachment, Disk scheduling, Disk management, Swap space management.

Protection: Goals of protection, Principles of protection, Domain of protection, Access matrix, Implementation of access matrix, Access control, Revocation of access rights. **10 Hrs**

Text Books:

1. **Operating System Principles –** Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 7th edition, Wiley-India, 2006.

Reference Books:

1. **Operating Systems: A Concept Based Approach** – D.M Dhamdhere, 2nd Edition, Tata McGraw- Hill, 2002.
2. **Operating Systems** – William Stallings, 5th Edition, PHI, 2006.

Course Title: Programmable Logic Controller & SCADA			
Course Code:P15EE661	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Content

Unit – I

Introduction: Introduction to Programmable Logic Controller(PLC),roll of PLC in automation, advantages and disadvantages, internal architecture, sourcing and sinking, PLC System, IEC Standards, Programming PLC, characteristics of I/O devices, input devices and output Devices(Relay, DC Motor, Stepper Motor) **10hrs**

Unit - II

Applications & I/O Processing: PLC applications (conveyor belt, lift, liquid level monitoring, packages on conveyor belt systems), I/O processing, input/output units, signal conditioning, serial and parallel communications, remote connections, networks, processing inputs I/O, addresses. **10hrs**

Unit – III

Programming & Internal Relays: ladder diagrams, function blocks, multiple outputs, location of stop and emergency switches, Instruction list, sequential function charts and structured texts, Internal Relay: Battery-backed relays, one-short operation, set and reset, master control relay. **10hrs**

Unit – IV

Timers, Counters & shift registers:. Types of timers, On-delay timers, Off-delay timers, Pulse timer, Programming Examples, forms of counters, programming, up and down counting, timers with counters, sequencer, Shift registers, ladder programs **10hrs**

Unit – V

Data handling & SCADA: registers and bits, data handling, Introduction to SCADA, Role of SCADA in automation, SCADA Architecture, Elements of SCADA ,Remote terminal unit, Master Terminal unit, Input/ Output, Applications. **10hrs**

Text Books:

1. w.Bolton, "Programmable Logic Controllers"- 6th edition, Elsevier-newness,2015
2. Jitender Singh, Monika Deswal, “PLC & SCADA” -laxmi publication,2015

Reference Books:

1. Stuart A. Boyer, “Scada: Supervisory Control And Data Acquisition”- 2nd edition,1999,the Instrumentation, Systems, and Automation Society
2. L.A.Bryan, E.A.Bryan,-"Programmable Controller Theory and applications"-2nd edition, An Industrial text company publication,1997.

Course Title: Illumination Engineering			
Course Code:P15EE662	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

COURSE CONTENT

Unit – I

Sources of light: Day light, artificial light sources, energy radiation, visible spectrum of radiation, black body radiation and full radiator. Incandescence, dependence of light o/p on temperature. Theory of gas discharge and production of light. **10Hrs**

Unit – II

Measurement of light: Radiometric and photometric quantities, units of measurement, standardization. Measurement of light distribution, direct and diffused reflection, fundamental concepts of colourimentry and measurement of colour. **10Hrs**

Unit – III

Types of lamps: GLS, Tungsten - halogen, Discharge, low pressure sodium vapour fluorescent, LED, LCD, metal - halide, IR and VV lamps - their construction, filament material, theory of operation, life, characteristics and application. **10Hrs**

Unit – IV

Design, objectives and specifications of lighting and systems: Design of luminance, electrical circuits and auxiliaries, basic lighting design, consideration and lighting parameters for extension lighting, interior lighting and day lighting. **10Hrs**

Unit – V

Energy conservation in lighting: Perception of light and colour, optical system of human eye, eye as visual processor. Reflection, refraction and other behaviour of light. **10Hrs**

Text Book:

1. Wadha C L: Utilization of Electric Power - New Age International LtdEdition 2011.
2. Wadha C L: Generation, Distribution and Utilization of electrical energy - New Age International Ltd, Edition 2011.

Reference Books:

1. Singh, Electric Power Generation, Transmission & Distribution, PHI, Edition 2014.
2. Partab H: Art and Science of Utilization of Electrical Energy, DhanpatRai & Sons, Edition 2010.
3. Fink & Beaty - Standard Hand Book for Electrical Engineers - McGraw Hill International, Edition 2010.

Course Title: Design Of Analog Control System			
Course Code:P15EE663	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

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 **8Hrs**

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 7^{th}& 8^{th} edition,2002.

REFERENCE BOOKS:

1. Modern control systems, Katsuhiko Ogata. PHI 4^{th}& 5^{th} edition, 2010.
2. Control Systems- Principles and Design, M.Gopal, McGraw Hill, 4^{th} 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 Title: Switch Mode Power Supply			
Course Code:P15EE664	**Semester: VI**	**L-T-P-H(Hrs): 2-2-0-4**	**Credits –4**
Contact period : Lecture: 50Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course content

UNIT - I

DC – DC CONVERTERS (BASIC CONVERTERS): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation, **10 Hrs**

UNIT - II

Principle of operation and analysis of buck-boost converter analysis, inductors current ripple and output voltage ripple, design considerations, buck-boost converter for discontinuous current operation, principle of operation and analysis of CUK converter, inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, Single Ended Primary Inductance Converter(SEPIC). **10 Hrs**

UNIT - III

DERIVED CONVERTERS: Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations, principle of operation and analysis of forward converter, design considerations, double ended(Two switch) forward converter, principle of operational analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half-bridge DC-DC converters, design considerations, current fed converters, multiple outputs. **10 Hrs**

UNIT - IV

RESONANT CONVERTERS: Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, series-parallel resonant DC-DC converter, resonant converters comparison, resonant DC link converter. **10 Hrs**

UNIT - V

POWER CONDITIONERS, UPS & FILTERS Introduction- Power line disturbances Power conditioners –UPS: offline UPS, Online UPS, Applications Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors. **. 10 Hrs**

TEXT BOOKS

1. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics Converters, Applications, and Design”, 3rd Edition, Wiley India Pvt Ltd, 2010.
2. Daniel W Hart, “Power Electronics”, Tata McGraw Hill, 2011.
3. Umanand L “ Power Electronics- Essentials and Applications”, Wiley 2011
4. Christophe P. Basso, “Switch-Mode Power Supplies Spice Simulations and Practical Designs” BPB Publication, 2010.

REFERENCE BOOKS

1. Umanand L and Bhatt S R, “Design of Magnetic Components for Switched Mode Power Converters”, New Age International, New Delhi, 2001
2. H W Whittington, B W Fynn, “Switched Mode Power Supplies: Design and Construction”, 1st Edition, Universities Press

Course title: Control system Lab			
Course Code:P15EEL67	**Semester: VI**	**L-T-P-H(Hrs): 0-0-3-3**	**Credits –1.5**
Contact period : Lecture: 36Hrs, Exam 3 Hrs		**Weightage : CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

Control system Lab:

1. Provide the basic knowledge of how to use MATLAB for Control System & DSP concepts.
2. Simulate a typical second order system and to determine the step response.
3. Study the Compensating networks viz., Lag, Lead and Lag- lead compensating networks.
4. Study the effect of P, PI, PD and PID controller.
5. Draw the speed – torque characteristic of a two - phase A.C. servomotor and D.C. servomotor.
6. Draw the Root locus and Bode for the given transfer function.

DSP - Lab:

1. Illustrate the Verification of sampling theorem.
2. Determine the impulse response and step response of a given system.
3. Determine the Circular convolution and Linear convolution of two given sequences.
4. Compute the N - point DFT of a given sequence and IDFT for given DFT points.
5. Design of Butterworth Low Pass IIIR filter

List of experiments

Control system Lab:

1. Provide the basic knowledge of how to use MATLAB for Control System & DSP concepts.
2. Simulate a typical second order system and to determine the step response.
3. Study the Compensating networks viz., Lag, Lead and Lag- lead compensating networks.
4. Study the effect of P, PI, PD and PID controller.
5. Draw the speed – torque characteristic of a two - phase A.C. servomotor and D.C. servomotor.
6. Draw the Root locus and Bode plots for the given open loop transfer function.

DSP - Lab:

7. Illustrate the Verification of sampling theorem.
8. Determine the impulse response and step response of a given system.
9. Determine the Circular convolution and linear convolution of two given sequences.
10. Compute the N - point DFT of a given sequence and IDFT for given DFT points.
11. Design of Butterworth Low Pass IIR filter

Course Outcome

After conducting all the experiments the student is able to

1. Analyse the performance of any second order system. (L4)
2. Analyse the effects and limitations of Lag, Lead, Lag-Lead compensators. (L4)
3. Explain the importance of different types of PID controllers.(L3)
4. Explain the behavior of AC &DC Servo motors. (L3)
5. Analyse the performance and stability of lower and higher systems.(L4)
6. Demonstrate the Verification of sampling theorem. (L3)
7. To determine the impulse response and step response of a given system. (L5)
8. Compute the Circular and Linear convolution of two given sequences. (L3)
9. Compute the N - point DFT and IDFT (L4)
10. Design of Butterworth Low Pass IIR filter (L5)

Course Articulation Matrix (CAM)														
Course Outcome (CO)			**Program outcome** (ABET/NBA-(3a-k))											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12
01	Analyze the performance of any second order electrical system.	**L4**	**L**	**L**	-	-	-	-	-	-	-	-	-	-
02	Analyze the effects and limitations of Lag, Lead, and Lag-Lead compensating networks Lag-Lead compensators.	**L4**	**L**	**L**	**L**	-	-	-	-	-	-	-	-	-
03	Explain the importance of different types of PID controllers	**L3**	**L**	**L**	-	-	-	-	-	-	-	-	-	-
04	Explain the behavior of AC &DC Servo motors.	**L3**	**L**	**L**	-	-	-	-	-	-	-	-	-	-
05	Analyze the performance and stability of lower and higher systems	**L4**	**L**	**L**	**L**	-	-	-	-	-	-	-	-	-
06	Demonstrate the Verification of sampling theorem.	**L3**	**M**	**M**	-	-	-	-		-	-	-	-	-
07	Determine the impulse response and step response of a given system	**L5**	**M**	**M**	-	-	-	-	-	-	-	-	-	-
08	Compute the Circular and Linear convolution of two given sequences.	**L3**	**M**	**M**	-	-	-	-	-	-	-	-	-	-
09	Compute the N - point DFT and IDFT	**L4**	**M**	**M**	-	-	-	-	-	-	-	-	-	-
10	Design of Butterworth Low Pass IIR filter	**L5**	**M**	**M**	-	-	-	-	-	-	-	-	-	-
	L-Low, M-Moderate, H-High													

Course Assessment Matrix (CAM)														
Course Outcome (CO)			**Program outcome** (ABET/NBA-(3a-k))											
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12
01	Analyze the performance of any second order electrical system.	**L4**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
02	Analyze the effects and limitations of Lag, Lead, and Lag-Lead compensating networks Lag-Lead compensators.	**L4**	**1**	**1**	**1**	-	-	-	-	-	-	-	-	-
03	Explain the importance of different types of PID controllers	**L3**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
04	Explain the behavior of AC &DC Servo motors.	**L3**	**1**	**1**	-	-	-	-	-	-	-	-	-	-
05	Analyze the performance and stability of lower and higher systems	**L4**	**1**	**1**	**1**	-	-	-	-	-	-	-	-	-
06	Demonstrate the Verification of sampling theorem.	**L3**	**2**	**2**	-	-	-	-		-	-	-	-	-
07	Determine the impulse response and step response of a given system	**L5**	**2**	**2**	-	-	-	-	-	-	-	-	-	-
08	Compute the Circular and Linear convolution of two given sequences.	**L3**	**2**	**2**	-	-	-	-	-	-	-	-	-	-
09	Compute the N - point DFT and IDFT	**L4**	**2**	**2**	-	-	-	-	-	-	-	-	-	-
10	Design of Butterworth Low Pass IIR filter	**L5**	**2**	**2**	-	-	-	-	-	-	-	-	-	-
	1-Low, 2-Moderate, 3-High													

Course Title: Electrical Auto Cad			
Course Code:P15EEL68	**Semester: VI**	**L-T-P-H(Hrs): 0-0-3-3**	**Credits –1.5**
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.

List of experiments

1. Draw Single Line 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.

Topic learning Objectives (TLOs):

1. To analyze and to draw the single line diagram of stations.
2. To analyse and to draw the layout diagram of some generating stations.
3. To design the winding diagrams of D.C. machines Simplex single layer Lap and wave winding.
4. To design the winding diagrams of D.C. machines Simplex double layer Lap and wave winding.
5. To design the winding diagrams of D.C. machines Duplex single layer Lap and wave winding.
6. To design the winding diagrams of D.C. machines Duplex double layer Lap and wave winding.
7. To design the winding diagrams of A.C. machines Integral slot full pitched single layer Lap and Wave windings.
8. To design the winding diagrams of A.C. machines Integral slot full pitched Double layer Lap and Wave windings.
9. To design the winding diagrams of A.C. machines Fractional pitched full pitched single layer Lap and Wave windings.

10. To design the winding diagrams of A.C. machines Fractional pitched full pitched single layer Lap and Wave windings.
11. To develop the Electrical machine assembly drawing for single and three phase core type transformer.
12. To develop the Electrical machine assembly drawing for single and three phase shell type transformer.

Text Book:

1. Performance& Design of Alternating Current machines, M. G. Say, CBS publishers,3rd Edition,2002.
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 Outcomes:	**Program Outcomes:**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12
1.Students should be able to draw single line diagram.	**L**	**H**	**M**									
2.Students should be able to develop the AC and DC Winding diagrams.	**M**	**L**	**H**									
3. Students should be able to draw the elevation of transformer and DC Machine.	**M**	**H**	**L**									

Course Title : Aptitude and Reasoning Development - EXPERT (ARDE)			
Course Code : P15HU610	**Semester : 6**	**L : T : P : H - 0 : 0 : 2 : 2**	**Credits: 1**
Contact Period: Lecture: 32 Hr, Exam: 3 Hr		**Weightage: CIE:50%; SEE:50%**	

Prerequisites : Number system, Concept of percentage, Analytical reasoning-2.

Course Learning Objectives (CLOs)

This course aims to

1. Explain different types of functions, representation of different functions on the graphs.
2. Describe the properties of quadratic equations and application of quadratic equations.
3. Demonstrates the principle of counting.
4. Differentiates between permutation and combination and solve problems conceptually.
5. Predict the probabilities in different scenarios and its application in our day-to-day life.
6. Evaluate the cause and effect of the statements logically.
7. Recognize different ways in which a statement can be strengthened or weakened.
8. Explain the criticality of data sufficiency chapter., universal methodology to solve any problem.
9. Analyse the data in a bar graph , pie chart and tabular column and line graph and the combination of these graphs.
10. Compare the data in different format and understand the difference between them

Course Content

Unit – I

Functions and Quadratic equations:

Functions: Basic methods of representing functions– Analytical representation, tabular representation, graphical representation of functions. Even and odd functions, Inverse of a function, Shifting of graph. Representation of standard set of equations. Methodology to tackle inverse functions.Graphical process for solving inequalities, graphical view of logarithmic function.

Quadratic equations: Theory, properties of quadratic equations and their roots, the sign of quadratic equation, Equations in more than one variable. Simultaneous equations, number of solutions of the simultaneous equations. **6 hrs**

Unit – II

Permutation and Combination: Understanding the difference between the permutation and combination, Rules of Counting-rule of addition, rule of multiplication, factorial function, Concept of step arrangement, Permutation of things when some of them are identical, Concept of 2^n, Arrangement in a circle.

Probability: Single event probability, multi event probability, independent events and dependent events, mutually exclusive events, non-mutually exclusive events, combination method for finding the outcomes. **8 hrs**

Unit – III

Analytical reasoning 3: Punchline: Introduction, format of the problem, An analysis, Does a suggested statement qualify as a punchline?. If a given statement fits as a punchline, what is its idea or wavelength?, The complete method of solving a punchline problem, Solved examples, conclusion, Sample company questions.

Strengthening and Weakening arguments: Format of the problem, An analysis, Suggested methods, solved examples, conclusion, sample company questions.

Cause and Effect : Cause and Effect—A theoretical discussion, Immediate cause, Principal cause, A quick check– Cause always antecedent. The strategy for solution. **6 hrs**

Unit IV

Data Sufficiency: Introduction, answer choices in data sufficiency, tips to solve data sufficiency problems, directions of questions, classification of sections in data sufficiency– Number system, Algebra, series and sequence, logical, geometry and mensuration, arithmetic.

6 hours

Unit V

Data Interpretation: Approach to interpretation - simple arithmetic, rules for comparing fractions, Calculating (approximation) fractions, short cut ways to find the percentages, Classification of data– Tables, Bar graph, line graph, Cumulative bar graph, Pie graph, Combination of graphs. Combination of table and graphs **6 hrs**

Reference Books:

1. "The Trachtenberg speed system of basic mathematics, published by Rupa publications.
2. CAT Mathematics by AbhijithGuha. published by PHI learning private limited.
3. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal , published by S. Chand private limited.
5. Quantitative aptitude for CAT by Arun Sharma, published by McGraw Hill publication.
6. Analytical reasoning by M.K Pandey BSC PUBLISHING.CO.PVT.LTD

Course Outcomes (CO)

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

1. Graphically represent the functions and analyze it. L5
2. Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them. L6
3. Effective solve the problems of permutation and combination. L4
4. Predict different possibilities by the principle of probability. L3
5. Interpret the data given in the graphical format and infer the results. L5
6. Analyze the statement critically and solve the questions from verbal logic section. L5

Topic Learning Outcomes

After learning all the topics of UNIT – I, the student is able to

1. Recognize the properties of a function by observing its graphical representation. L3
2. Write the general equations for the functions by analyzing the characteristics.L1
3. Write tabular and graphical representation of the fuctions.L1
4. Differentiate between even and odd functions.L2
5. Compose the inverse of a functions.L2
6. Analyze the shifting of graphs and combining movements.L5
7. Modify the equations under some constraints to get the required graph.L3
8. Design the logical graphical process for solving the inequalities.L4
9. Analyze the graphical view of logarithmic functions.L5
10. Compute the roots of linear, quadratic and cubic equations.L6
11. Describe the properties of quadratic equations and their roots.L1
12. Analyze the sign of quadratic expressions and infer the results graphically.L5

After learning all the topics of UNIT – II, the student is able to

1. Apply the fundamental principle of counting to solve basic level problems and apply its logic in complex problems.L2
2. Distinguish between permutation and combination.L4
3. Combine the principles of counting with combination to solve the problems on permutation.L4

4. Select and arrange “r” objects out of “n” objects under different constraints.L4
5. Criticize the restricted use of ${}^{n}P_{r}$.L6
6. Analyze the concept of step arrangement and apply its principles in problem solving.L5
7. Analyze the permutation of things when some of them are identical.L5
8. Apply the concepts of combination.L2
9. Describe the applications of the concept of 2^{n}.L1
10. Solve the problems under division of things into groups.L3
11. Differentiate between linear arrangement and circular arrangement.L3
12. Recognize the importance of probability. L4
13. Use the conjunction AND tool and OR tool.L2
14. Define an event and solve it under specific constraints.L1
15. Develop the ability to apply the concepts of probability and its applications in real file scenarios.L6

After learning all the topics of UNIT – III, the student is able to

1. Interpret the format of any given problem. L4
2. Interpret whether a given statement qualify as a punchline. L4
3. Analyze an idea or a wavelength. L5
4. Develop a methodology to solve a punchline problem. L3
5. Evaluate problems involving strengthening and weakness problem. L6
6. Device a universal strategy to solve the problems of logical reasoning. L3
7. Interpret cause and effect problems and solve them logically. L2
8. Differentiate between immediate cause and a principal cause and apply the knowledge of it in problem solving. L1

After learning all the topics of UNIT – IV, the student is able to

1. Distinguish between data sufficiency type problems and any other problem. L1
2. Apply the universal strategies taught in solving problems. L5
3. Apply the strategy to solve problems under the topics such as Number system, Algebra, series and sequence. L5
4. Apply the strategy to solve problems under the topics such as logical, geometry and mensuration, arithmetic. L5
5. Apply the knowledge of flow chart and mind map to tackle problems. L4

After learning all the topics of UNIT – V, the student is able to Demonstrate better interpretation and representation of data.L1

1. Discover various forms of data representation their advantages and disadvantages.L1
2. Analyze the data provided in the form of tabular column, pie graph, bar graph, line graph, combination of two or more. L5
3. Understand the concept of angles and area swept in a pie chart. L5
4. Apply simple arithematics and shortcuts to solve problems based on given graph. L2
5. Identify percentage hacks and use shortcuts to find the actual value when percentage is given.L4
6. Convert ratios to percentages and vice versa. L4
7. Analyze case studies based on statistical data. L5
8. Identify the limitations of each data representation technique. L6
9. Choose better, the correct method to represent statistics in corporate presentations. L2

Course Articulation Matrix (CAM)													
Course Outcome (CO)	**Program Outcome (ABET/NBA-(3a-k))**												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12
Graphically represent the functions and analyze it.	L5	M	-	-	-	M	-	-	-	-	-	-	-
Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them.	L6	M	-	-	-	-	-	-	-	-	-	-	-
Effective solve the problems of permutation and combination.	L4	H	-	-	-	M	-	-	-	M	-	-	-
Predict different possibilities by the principle of probability.	L3	H	-	-	-	-	-	-	-	M	-	-	-
Interpret the data given in the graphical format and infer the results.	L5	M	-	-	-	-	-	-	-	-	-	-	-
L- Low, M- Moderate, H-High													
Course Assessment Matrix (CaM)													
Course Outcome (CO)	**Program Outcome (ABET/NBA-(3a-k))**												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12
Graphically represent the functions and analyze it.	L5	M	-	-	-	M	-	-	-	-	-	-	-
Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them.	L6	M	-	-	-	-	-	-	-	-	-	-	-
Effective solve the problems of permutation and combination.	L4	H	-	-	-	M	-	-	-	M	-	-	-
Predict different possibilities by the principle of probability.	L3	H	-	-	-	-	-	-	-	M	-	-	-
Interpret the data given in the graphical format and infer the results.	L5	M	-	-	-	-	-	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High													