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.

Dr. Umesh D.R.   **Dr. Nagarathna**
Deputy Dean (Academic)   Dean (Academic)
Associate Professor   Professor
Dept. of Computer Science &Engg.   Dept. of Electrical & Electronics Engg

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

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Profile

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

The Department of Electrical and Electronics Engineering was established right from the inception of the institute in the year 1962. The various programs offered by the Department are B.E., M.Sc., (Engg.) by research and research leading Ph.D affiliated to Visvesvaraya Technological University (VTU), Belagavi. Also, Department is affiliated for Ph.D program with University of Mysore, Mysore and Kuvempu University, Shimoga. About 100 research papers have been published by the Department faculty members in various International & National journals and conferences.

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

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

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

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401
(An Autonomous Institution under VTU, Belgaum)

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

A.Program Educational Objectives (PEO)

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

 PEO 1.1.Progressing professional career
 PEO 1.2.Higher education

PEO2: Analyze real life problems, design computing systems appropriate to its solutions that are technically sound, economically feasible and socially acceptable

 PEO 2.1.Analyzereal life problem
 PEO 2.2.Design and develop economically feasible and socially acceptable
 Computing Solutions

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

 PEO 3.1.Professional conduct and interpersonal skills
 PEO 3.2.Adapting to current trends in technology

B. Programme Outcomes (PO)

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

PO-2: Graduates will Identify, formulate and solve Electrical and Electronics 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 Department	L	T	P	Credits	CIE	SEE	Total
1	P18EE51	Management and Entrepreneurship	EE	4	-	-	4	50	50	100
2	P18EE52	Power Electronics	EE	4	-	-	4	50	50	100
3	P18EE53	Linear Control Systems	EE	4	-	-	4	50	50	100
4	P18EE54	Electrical Machines-II	EE	4	-	-	4	50	50	100
5	P18EE55X	Professional Elective – I	EE	2	2	-	3	50	50	100
6	P18EEL56	Power Electronics Lab	EE	-	-	3	1.5	50	50	100
7	P18EEL57	Electrical Machines Lab - II	EE	-	-	3	1.5	50	50	100
8	P18EEL58	Skill Oriented Laboratory – I MATLAB & Simulink	EE	-	-	2	1	50	50	100
9	P18EE59X	Technical Skills – I	EE	-	2	-	1	50	50	100
10	P18HU510	Aptitude and Reasoning Development - Advance (ARDI)	HU	-	2	-	1	50	50	100
		Total					**25**	**500**	**500**	**1000**

	Professional Elective – I			Technical Skills – I	
Sl. No	Course Code	Course title	Sl. No	Course Code	Course title
1.	P18EE551	Power Transmission and Distribution	1.	P18EE591	MATLAB programming
2.	P18EE552	Illumination Engineering	2.	P18EE592	C ++ Programming
3.	P18EE553	Fuzzy Logic	3.	P18EE593	Software Engineering
4.	P18EE554	Data communication and networking	4.	P18EE594	Hybrid Electric Vehicles

Note: Students can undergo Swayam online courses anytime during fifth semester to eight semester and credits will be awarded in eight semester.

P.E.S COLLEGE OF ENGINEERING, MANDYA

(An Autonomous Institution under VTU, Belgaum)
SCHEME OF TEACHING AND EXAMINATION

VI Semester B.E Electrical & Electronics Engineering

Sl. No.	Course Code	Course Title	Teaching Department	L	T	P	Credits	CIE	SEE	Total
				VI – Semester						
1	P18EE61	Power System Analysis & Stability	EE	4	-	-	4	50	50	100
2	P18EE62	Digital Signal Processing	EE	4	-	-	4	50	50	100
3	P18EE63	Electrical Machine Design	EE	4	-	-	4	50	50	100
4	P18EE64X	Professional Elective – II	EE	2	2	-	3	50	50	100
5	P18EE65X	Open Elective-I	EE	3	-	-	3	50	50	100
6	P18EEL66	Control System & DSP Lab	EE	-	-	3	1.5	50	50	100
7	P18EEL67	Electrical Auto CAD Lab	EE	-	-	3	1.5	50	50	100
8	P18EEL68	Skill Oriented Laboratory - II Labview & Multisim	EE	-	-	2	1	50	50	100
9	P18HU69	Technical Skills – II	HU	2	-	-	1	50	50	100
		Total					23	450	450	900

List of Electives					
Professional Elective – II			**Open Elective – I**		
Sl. No	Course Code	Course title	Sl. No.	Course Code	Course title
1.	P18EE641	Switchgear & Protection	1.	P18 EE651	Power Plant Engineering
2.	P18 EE642	Modern Control Theory	2.	P18 EE652	Illumination Engineering
3.	P18 EE643	Embedded System	3.	P18 EE653	Fuzzy Logic
4.	P18 EE644	PLC & SCADA	4.	P18 EE654	Estimation and Costing

Electrical and Electronics Engineering

V SEMESTER

Course Title: MANAGEMENT AND ENTREPRENEURSHIP			
Course Code:P18EE51	Semester: V	L-T-P-H(Hrs): 2-0-0-4	Credits – 4
Contact period : Lecture: 52Hrs, Exam 3 Hrs		Weightage : CIE:50 SEE:50	

This course aims is to:

1. The course helps students to apply skills pertinent to the management and entrepreneurial management of both existing and emerging technologies.

2. Understand engineering safety, strategies, and life cycle properties of a project.

3. Be able to plan, organize staff and schedule in both small and large organizations with an engineering context.

Unit - I

MANAGEMENT: Introduction Meaning nature and characteristics of Management, Scope and functional areas of management, Management as a science, art or profession Management & Administration Role of Management, Levels of Management, Development of Management Thought early management approaches and Modern management approaches.

PLANNING: Nature, importance and purpose of planning process, objectives and types of plans (Meaning only), steps in planning & planning premises Hierarchy of plans.   **11Hrs**

Self-study: Motivation theory, wages and incentives.

Unit- II

Organizing and Staffing: Nature and purpose of organization, principles of organization ,types of organization, Committees, Centralization V/s Decentralization of authority and responsibility Span of control, MBO and MBE (Meaning only), Nature and importance of Staffing, process of Selection & Recruitment (in brief), functions of HRM.

Directing and Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication Meaning and importance. Co-ordination meaning and importance and Techniques of Co-ordination. Meaning and steps in controlling-Essentials of a sound control system-Methods of establishing control (in brief).   **12Hrs**

Self-Study: Structures of HR department.

Unit -III

Entrepreneur: Meaning of Entrepreneur, Evolution of Concept, Functions of Entrepreneur, Types of Entrepreneur, Evolution of Entrepreneurship, Development of Entrepreneurship, Stages in entrepreneurial process, Role of Entrepreneurs in Economic development, entrepreneurship in India, entrepreneurship –its barriers.   **08Hrs**

Self-Study: Basics of Digital Marketing

Unit - IV

Small Scale Industry: Definition; Characteristics; Need and rationale: Objectives, Scope, role of SSI in Economic Development. Advantages of SSI. Steps to start an SSI, Government policy towards SSI, Different Policies of SSI and Government Support on SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI. Effect of WTO / GATT Supporting Agencies of Government for SSI-Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition only)   **11Hrs**

Self-Study: Study of any small scale industry.

Unit -V

Preparation of Project: Meaning of Project, Project Identification, Project Selection, Project Report, Need and significance of Report, Contents, and formulation, Guidelines by Planning Commission for Project Report, Network Analysis, Errors of Project Report, and Project Appraisal.

Identification of Business Opportunities: Market Feasibility Study: Technical Feasibility Study, Financial Feasibility Study & Social Feasibility study.   **10Hrs**

Self-study: Study of Project management in industry.

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.
2. Dynamics of Entrepreneurial Development & Management, Dr. Vasant DesaiHimalaya Publishing House, 2011, ISBN:9789350244548

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 Outcomes

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

CO1: Apply the knowledge of basic management to analyze the administration and importance of planning.

CO2: Analyze the different types of organizations, the authority, the responsibilities, and the staffing and hiring processes

CO3: Establish a process for entrepreneurship and management.

CO4: Examine the characteristics and policies of small businesses

CO5: Analyze the need and significance of project report, Market Feasibility Study.

Course Articulation Matrix														
Course Outcomes (CO)	**Program Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Apply the knowledge of basic management to analyze the administration and importance of planning.	2	2	-	-	-	-	-	-	2	2	-	2	-	-
Analyze the different types of organizations, the authority, the responsibilities, and the staffing and hiring processes	2	3	-	-	-	-	-	1	2	2	-	-	-	-
Establish a process for entrepreneurship and management.	2	3		-	-	-	-	-	2	2		-	-	-
Examine the characteristics and policies of small businesses	2	3	-	-	-	-	-	1	2	2	1	-	-	-
Analyze the need and significance of project report, Market Feasibility Study.	2	3	-	-	-	-	-	-	2	2	1	-	-	-
1-Low				**2-Medium**							**3-High**			

Topic Learning Objectives (Unit wise)

Unit I

By the end of the topic, student will be able to;

1. Discuss Meaning nature and characteristics of Management
2. Explain Scope and functional areas of management, Management as a science, art or profession
3. Explain Role of Management, Levels of Management and Development of Management Thought early management approaches Modern management approaches.
4. Define Nature, importance and purpose of planning process and types of plans
5. Explain Decision making Importance of planning, steps in planning & planning premises Hierarchy of plans.

Unit II

By the end of the topic, student will be able to

1. Discuss Nature and purpose of organization, principles of organization Types of organization
2. Define Committees Centralization V/s Decentralization of authority and responsibility Span of control
3. Explain Nature and importance of Staffing Process of Selection &Recruitment
4. Discuss Meaning and nature of directing Leadership styles, Motivation Theories, Communication Meaning and importance
5. Discuss and Explain Meaning and steps in controlling Essentials of a sound control system Methods of establishing control

Unit III

By the end of the topic, student will be able to

1. Explain Meaning of Entrepreneur, Evolution of Concept, Functions of Entrepreneur, Types of Entrepreneur
2. Discuss Evolution of Entrepreneurship, Development of Entrepreneurship
3. Explain Stages in entrepreneurial process, Role of Entrepreneurs in Economic development
4. Discuss entrepreneurship in India, entrepreneurship – its barriers

Unit IV

By the end of the topic, student will be able to

1. Define Characteristics; Need and rationale: Objectives, Scope, and role of SSI in Economic Development. Advantages of SSI
2. Explain Steps to start an SSI Government policy towards SSI, Different Policies of SSI, Government Support on SSI during 5 year plans
3. Discuss Impact of Liberalization, Privatization and Globalization on SSI. Effect of WTO / GATT Supporting Agencies of Government
4. Define and Explain Functions; Types of Help; Ancillary Industry and Tiny Industry

Unit V

By the end of the topic, student will be able to

1. Discuss Meaning of Project, Project Identification, Project Selection, Project Report, Need and significance of Report, Contents, formulation
2. Define and Explain Guidelines by Planning Commission for Project Report, Network Analysis Errors of Project Report, Project Appraisal
3. Discuss Identification of Business Opportunities
4. Explain Market Feasibility Study: Technical Feasibility Study, Financial Feasibility Study & Social Feasibility study.

Review Questions

1. Explain Different Characteristics of Management
2. Distinguish between Management and Administration
3. Explain functional areas of Management
4. Briefly Explain each component of Planning Characteristics
5. Explain Principles of Organization
6. Define Leadership. Explain basic styles of Leadership
7. Explain steps involved in Controlling
8. Explain Functions of Entrepreneur with suitable Examples
9. Explain how small scale industries help in Economic Development of India
10. Explain Objectives and Functions of WTO
11. Discuss SIDBI. Explain need for institutional support for SSI
12. What are functions of KSFC and TECSOK
13. Differentiate between PERT and CPM
14. Define and Explain Steps followed in Project Appraisal

Lesson Plan

Unit I

1. Introduction Meaning nature and characteristics of Management
2. Scope and functional areas of management
3. Management as a science, art or profession Management
4. Administration Role of Management Levels of Management,
5. Development of Management Thought
6. Early management approaches Modern management approaches.
7. Nature and importance of planning process
8. Purpose of planning process and objectives of planning
9. Types of plans
10. Decision making Importance of planning
11. Steps in planning & planning premises
12. Hierarchy of plans.

Unit II

1. Nature and purpose of organization, principles of organization
2. Types of organization
3. Committees
4. Centralization V/s Decentralization of authority and responsibility
5. Span of control, MBO and MBE
6. Nature and importance of Staffing Process of Selection &Recruitment
7. Meaning and nature of directing Leadership styles,
8. Motivation Theories, Communication Meaning and importance
9. Coordination meaning and importance
10. Techniques of Co-ordination.
11. Meaning and steps in controlling
12. Essentials of a sound control system Methods of establishing control

Unit III

1. Meaning of Entrepreneur, Evolution of Concept
2. Functions of Entrepreneur
3. Types of Entrepreneur
4. Evolution of Entrepreneurship
5. Development of Entrepreneurship
6. Stages in entrepreneurial process
7. Role of Entrepreneurs in Economic development
8. Entrepreneurship in India, entrepreneurship – its barriers

Unit IV

1. Definition, Characteristics of SSI
2. Need, rationale and Objectives of SSI
3. Scope, Role of SSI in Economic Development. Advantages of SSI.
4. Steps to start an SSI, Government policy towards SSI, Different Policies of SSI

5. Government Support on SSI during 5 year plans.
6. Impact of Liberalization, Privatization, Globalization on SSI.
7. Effect of WTO / GATT Supporting Agencies of Government for SSI Meaning.
8. Nature of support, Objectives, Functions, Types of Help

Unit V

1. Meaning of Project, Project Identification
2. Project Selection, Project Report, Need and significance of Report
3. Contents, Formulation
4. Guidelines by Planning Commission for Project Report
5. Network Analysis, Errors of Project Report
6. Project Appraisal Identification of Business Opportunities
7. Market Feasibility Study: Technical Feasibility
8. Study, Financial Feasibility Study & Social Feasibility study.

Electrical and Electronics Engineering

Course Title: Power Electronics			
Course Code: P18EE52	**Semester: V**	**L-T-P-H: 4-0-0-**	**Credits – 4**
Contact period : Lecture: 52Hrs, 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.
Power Transistors: Introduction, Power bipolar junction transistors, Power MOSFETs, IGBTs and their Switching characteristics.
Self-Study: Peripheral effects and their remedies   **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, Thyristor firing circuits, di/dt and dv/dt protection, Thyristor types, Series and parallel operation of Thyristors.
Self-Study: Thyristor Gate Characteristics.   **11Hrs**

Unit – III

Thyristor Commutation Techniques: Introduction, Commutation - natural, forced, 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.
Self-Study: Self Commutation   **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, Single phase half &full bridge inverters, Analysis of single phase inverters, voltage control of single phase inverters, 3phase voltage source inverters.

Course Articulation Matrix															
	Course Outcomes	**Program Outcomes**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of basic science to study various types of semiconductor devices, their control and switching characteristics.	3	2	-	-	-	-	-	-	-	-	-	2		2
2	Analyze AC-DC switching devices characteristics and performance.	2	3	1	-	-	-	-	-	-	-	-	-	-	2
3	Examine the various commutation techniques and AC Voltage controllers.	2	3	-	-	-	-	-	-	-	-	-	-	-	2
4	Analyze the various types of converter/inverter circuits.	2	3	-	-	-	-	-	-	-	-	-	-	-	2
5	Appraise the various types of controlled rectifiers.	2	3	-	-	-	-	-	-	-	-	-	-	-	2
1-Low				**2-Medium**								**3-High**			

Self-Study: Performance parameters   **11Hrs**

Unit –V

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

Self-Study: Dual 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: Apply the knowledge of basic science to study various types of semiconductor devices, their control and switching characteristics.

CO2: Analyze AC-DC switching devices characteristics and performance.

CO3: Examine the various commutation techniques and AC Voltage controllers.

CO4: Analyze the different types of converter/inverter circuits.

CO5: Appraise the various types of controlled rectifiers

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 auxilary 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 a 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 Title: LINEAR CONTROL SYSTEMS			
Course Code:P18EE53	Semester: V	L-T-P-H(Hrs): 3-1-0-4	**Credits – 4**
Contact period : Lecture: 52Hrs, Exam 3 Hrs		Weightage: CIE:50SEE:50	

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**
Self-study: Regulating systems, Effect of feedback on time constant of a control system.

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**
Self-study: Dynamic, Design considerations for higher order systems.

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.   **11Hrs**
Self-study: Relative stability analysis, Cancellation of poles of G(s) with Zeros of H(s).

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.

11Hrs

Self-study: Transport lag, Relation between system type and log-magnitude curve, determination of static position.

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

Self-study: Drawing Nyquist plots of a system defined in state space, log-magnitude versus phase plots.

Text Books:

1. Benjamin .C Kuo and FaridGolnaraghi "Automatic Control Systems", , 8th edition, Wiley India, 2010.
2. I.J Nagrath& M. Gopal "Control System Engineering", New Age International PriLtd, 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: Apply the knowledge of mathematics to develop the different models of control system.
CO2: Analyze the time domain response of first and second order system.
CO3: Examine the stability analysis using time domain response.
CO4: Analysis of frequency response using Bode plot
CO5: Evaluate the stability of system using Polar and Nyquist Plot.

Course Articulation Matrix														
Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1 Apply the knowledge of mathematics to develop the different models of control system	3	3	-	-	-	-	-	-	-	-	-	2	-	2
2 Analyze the time domain response of first and second order system.	3	3	-	-	-	-	-	-	-	-	-	-	-	2
3 Examine the stability analysis using time domain response.	3	3	-	-	-	1	-	-	-	-	-	-	-	2
4 Analysis of frequency response using Bode plot	3	3	-	-	-	-	-	-	-	-	-	-	-	2
5 Evaluate the stability of system using Polar and Nyquist Plot.	3	3	-	-	2	-	-	-	-	-	-	-	-	2
1-Low				2-Medium							3-High			

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) undamped 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_{u} 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. 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. 6. Draw Nyquist plots and discuss the stability of closed   loop system from the given open-
8. loop transfer function.
9. 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) underdamped system (ii) undamped 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) undamped 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 ꞇr for the second order system in terms of ξ and ꞇn.

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 Title : ELECTRICAL MACHINES –II			
Course Code:P18EE54	Semester: V	L-T-P-H(Hrs): 4-0-0-4	Credits – 4
Contact period : Lecture: 52Hrs, 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, Compensating winding.
Self-Study: Use of Inter poles.   **10 Hrs**

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, Necessity of a Starters, 3-point starter , Applications of DC motor
Self-Study: 4-point Starter   **10 Hrs**

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
Self-Study: Construction, principle of operation and Applications: Permanent magnet DC motor.   **11 Hrs**

Unit-IV

Synchronous Generator: Principle of operation, Construction of salient & non-salient pole machines, armature windings, Coil span factor, Distribution factor, Chorded coils and EMF equation.
Voltage Regulation: Significance, EMF, MMF & ZPF methods.
Self-Study: Harmonics and its elimination   **11 Hrs**

Unit-V

Synchronization: Parallel operation of alternators: Reasons & Conditions, Synchronization: synchroscope, 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, V and inverted V curves.

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

Self-Study: Hunting in synchronous machines and Damper windings**10 Hrs**

Text Books:
1. Ashfaq Hussain "Electrical Machines", Dhanapath Rai& Co, 3rd Edition, Reprint 2015.
2. B.L Theraja "Electrical Technology" Volume2, 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

Course Outcomes

After learning all the units of the course, the student is able to
Apply the knowledge of basic electrical laws to study the operating principle DC Generators.
CO1: Apply the knowledge of basic electrical laws to study the operating principle DC Generators.
CO2: Analyze the performance characteristics of DC Motors
CO3: Apply the different testing methods to examine the desired parameters of DC Machines
CO4: Analysis of voltage regulation for a synchronous generator.
CO5: Analyze synchronous motor performance under both excitation and asynchronous conditions

Course Articulation Matrix															
Course Outcome - CO		**Program Outcomes**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of basic electrical laws to study the operating principle DC Generators.	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	Analyze the performance characteristics of DC Motors.	1	3	-	-	-	-	-	-	-	-	-	-	2	
3	Apply the different testing methods to examine the desired parameters of DC Machines	3	3	-	-	-	1	-	-	-	-	-	-	2	
4	Analysis of voltage regulation for a synchronous generator.	2	3	-	-	-	-	-	-	-	-	-	-	2	
5	Analyze synchronous motor performance under both excitation and asynchronous conditions.	3	3	-	-	-	-	-	-	-	-	-	-	2	
1-Low					**2-Medium**								**3-High**		

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 Title: POWER TRANSMISSION & DISTRIBUTION			
Course Code:P18EE551	Semester: V	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, 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 overhead 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.

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, Stringing charts.

Self-Study: Tension & sag at erection.   **08Hrs**

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.

Self-Study: Testing of cables.

                                                                                08Hrs

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.

Self-Study: Skin effect & Proximity effect**.**   **08Hrs**

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.

Self-Study: performance of ring transmission lines.   **08Hrs**

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.

Self-Study: AC Distributors- when the load pfs referred to supply voltage point.   **08Hrs**

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

CO1: Apply the knowledge of basic science to study power transmission & distribution scheme.

CO2: Analyze the classification of line conductors and voltage distribution in insulators and UG cables.

CO3: Evaluate the line parameters for single phase and three phase system.

CO4: Analyze the performance of transmission lines with different configurations.

CO5: Examine the corona phenomenon & distribution system scheme.

Course Outcomes		Program Outcomes													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO1	PSO2
1	Apply the knowledge of basic science to study power transmission & distribution scheme.	3	2	-	-	-	-	-	-	-	-	-	1	2	-
2	Analyze the classification of line conductors and voltage distribution in insulators and UG cables.	2	3	-	-	-	2	-	-	-	-	-	-	2	
3	Evaluate the line parameters for single phase and three phase system.	2	3	-	-	-	-	-	-	-	-	-	-	2	
4	Analyze the performance of transmission lines with different configuratio ns.	2	3	-	-	-	-	-	-	-	-	-	1	2	
5	Examine the corona phenomenon & distribution system scheme.	2	3	-	-	-	2	-	-	-	-	-	-	2	
1-Low						**2-Medium**								**3-High**	

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 ower 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 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
28. 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
29. Discuss the effect of load pf on regulation of a 3-phase transmission line
30. What are ABCD constants? Derive an expression for ABCD constants of a medium transmission lines using nominal T_1 method. Show that $AD - BC = 1$.
31. 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
32. 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 310×10^{-6} mho using T-method. Determine ABCD constants of the line, sending end voltage, regulation of the line
33. What is Ferranti effect, explain
34. What is corona? Derive expression for the disruptive critical voltage and visual critical voltage
35. State and explain any four factors affecting corona and corona power loss (L1).
36. Mention the advantages and disadvantages of corona. State methods of reducing corona effect.
37. 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.
38. Write short note on feeders, distributors and service mains.
39. How D.C. distributors are classified? Write the relative merits and demerits of ring main over radial distribution systems.
40. 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.
41. 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.
42. 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

Electrical and Electronics Engineering

Course Title: Illumination Engineering			
Course Code:P18EE552	Semester: V	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50	

Course LearningObjectives(CLOs)

This course is aim is to

1. Understand the different sources and energy radiation of lights
2. Understand the different measuring types and types of lights
3. Understand the different lighting parameters and design of luminance

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, Theory of gas discharge and production of light. **08Hrs**
Self-study: Dependence of light output on temperature

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. **08Hrs**
Self-study: Measurement of colour.

Unit – III
Types of lamps: GLS, Tungsten - halogen, Discharge, low pressure sodium vapour fluorescent, metal - halide, IR, VV lamps and LED lamps- their construction, filament material, theory of operation, life, characteristics.

08Hrs
Self-study: Applications of various lamps

Unit – IV
Design, objectives and specifications of lighting and systems: Design of luminance, basic lighting design, consideration and lighting parameters for extension lighting, interior lighting and day lighting. **08Hrs**
Self-study: Electrical circuits and auxiliaries

Unit – V
Energy conservation in lighting: Perception of light and colour, optical system of human eye, eye as visual processor, Reflection, Refraction. **08Hrs**
Self-study: Behaviour of light

Text Book:
1. Wadwha C L: Utilization of Electric Power - New Age International LtdEdition 2011.
2. Wadwha 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 Outcomes

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

1. CO1: Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space
2. CO2: Perform calculations on photometric performance of light sources and luminaries for lighting design
3. CO3: Analyze the detailed information about modern lamps and their accessories
4. CO4: Evaluate different types of lighting designs and applications
5. CO5: Demonstrate Energy conservation in lighting

Course Articulation Matrix

Course Outcome (CO)	Program Outcome													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space	3	3	1	-	-	2	2	-	-	-	-	-	-	-
Perform calculations on photometric performance of light sources and luminaries for lighting design	3	3	3	-	-	2	2	-	-	-	-	-	-	-
Analyze the detailed information about modern lamps and their accessories	3	3	3	-	-	2	2	-	-	-	-	-	-	-
Evaluate different types of lighting designs and applications	3	3	-	-	-	2	2	-	-	-	-	-	-	-
Demonstrate Energy conservation in lighting	3	3	-	-	-	3	3	-	-	-	-	-	-	-

Course Title:FUZZY LOGIC			
Course Code:P18EE553	Semester: V	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50	

Course Learning Objectives(CLOs)

This course aims is to:

1. To understand the properties and operations of fuzzy sets

2. To understand the relations and properties of fuzzy sets

3. To get the knowledge of different methods of membership function.

4. To study different variables and rules of fuzzy system

5. To understand the operations of fuzzy logic control system

Course content
Unit-I

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.
Self-Study: Obtain the Examples of fuzzy sets for different engineering applications.
08Hrs

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.
Self-Study: Write MATLAB programs for the different operations of the fuzzy sets and Fuzzy Relations. **08Hrs**

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.
Self-Study: Write MATLAB programs for the different Fuzzification, and Defuzzification methods **08Hrs**

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.
Self-Study: Detailed study and make   Comparisons   between   Mamdani   and   Sugino methods. **08Hrs**

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.
Self-Study: Applications of FLC systems.   **08Hrs**

Text Books:
1. Timothy J. Ross, Fuzzy logic with Engineering applications**,** McGraw-Hill/Wiley India Publications.2nd Edition. 2009.
2. D. Driankar, H. Hellendoom and M. ReinfrankNarosa An introduction to Fuzzy control, Publishers India, 1996. (Reprint 2009)
Reference Books:
  1. S.N.Shivanandam, S.N.Deepa,Principles of Soft Computing, Wiley India (pvt) Ltd publications, First edition 2007

Course Outcomes

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

CO1: Apply the knowledge of properties fuzzy sets to the control systems

CO2: Analysis of different types of classical and fuzzy relations

CO3: Analyze the different methods of membership function in fuzzification and defuzzification.

CO4: Examine theory of approximate reasoning with different fuzzy rules

CO5: Discuss fuzzy knowledge based controllers using different of membership functions.

Course Articulation Matrix															
Course Outcomes	**Program Outcomes**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of properties fuzzy sets to the control systems	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	Analysis of different types of classical and fuzzy relations	3	2	-	-	-	-	-	-	-	-	-	-	1	-
3	Analyze the different methods of membership function in fuzzification and defuzzification.	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	Examine theory of approximate reasoning with different fuzzy rules	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	Discuss fuzzy knowledge based controllers using different of membership functions	3	2	-	-	-	-	-	-	-	-	-	-	2	-
1-Low	**2-Moderate**					**3-High**									

Course Title: Data communication and networking			
Course Code:P18EE554	Semester: V	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, Exam 3 Hrs		Weightage : CIE:50 SEE:50	

Unit-I

Introduction: Data communications; networks; the internet; protocols and standards; layered tasks; the OSI model and the layers in the OSI model; TCP / IP protocol suite, addressing.
Self-Study: Transmission impairment   **08Hrs**

Unit-II

Data, signals and digital transmission: Analog and digital, periodic analog signals, digital signals, transmission impairment, data rate limits, performance, analog-to-digital conversion, transmission modes.
Self-Study: digital-to-digital conversion   **08Hrs**

Unit-III

Transmission media: Guided media, unguided media: wireless, circuit-switched networks, datagram networks, virtual circuit networks.
Self-Study: structure of a switch   **08Hrs**

Unit-IV

Error detection and correction: Introduction, block coding, linear block codes, cyclic codes, checksum, framing, flow and error control, protocols, random access, aloha, controlled access.
Self-Study: noisy and noiseless channels   **08Hrs**

Unit-V

Wired lans & wireless lans: IEEE standards, standard ethernet, changes in the standard, fast ethernet, IEEE 802.11, Bluetooth.
Self-Study: gigabit Ethernet   **08Hrs**

Textbooks:

1. Behrouz A. Forouzan, Data Communications and Networking 5E, 5th Edition, Tata McGraw-Hill, 2013.

Reference Books:

1. Alberto Leon-Garcia and Indra Widjaja: Communication Networks - Fundamental Concepts and Key architectures, 2nd Edition Tata McGraw-Hill, 2004.

2. William Stallings: Data and Computer Communication, 8th Edition, Pearson Education, 2007.

3. Larry L. Peterson and Bruce S. Davie: Computer Networks – A Systems Approach, 4th Edition, Elsevier, 2007.

Course Outcomes

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

CO1: Apply the knowledge of computer basics to the study of different types of communication protocols

CO2: Analyze the different types of analog and digital signals

CO3: Examine the different types of transmission networks used in networking.

CO4: Analyze the error detection and correction.

CO5: Analyze the different types wireless networks.

Course Articulation Matrix														
Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1 Apply the knowledge of computer basics to the study of different types of communication protocols	3	2	-	-	-	-	-	-	-	-	-	-	-	-
2 Analyze the different types of analog and digital signals	2	3	-	-	-	-	-	-	-	-	-	-	-	-
3 Examine the different types of transmission networks used in networking.	2	3	-	-	-	-	-	-	-	-	-	-	-	-
4 Analyze the error detection and correction.	2	3	-	-	-	-	-	-	-	-	-	-	-	-
5 Analyze the different types wireless networks.	2	3	-	-	-	-	-	-	-	-	-	-	-	-
1-Low **2-Moderate** **3-High**														

Course Title: POWER ELECTRONICS LAB			
Course Code:P18EEL56	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. Speed control of Universal motor /single phase Induction motor.
4. AC Voltage Controllers using Triac-Diac combination
5. Single phase Half control bridge rectifier operation with R-load & Motor load.
6. Single phase Full control bridge rectifier operation with R-Load & Motor load.
7. Chopper operation with constant and variable Frequency Control.
8. Study of Commutation circuits.
9. Single phase Bridge Inverter without firing circuit.
10. Single phase PWM inverter-IGBT Based.
11. Self-study experiment-SCR turn on using synchronized UJT relaxation oscillator
12. Self-study experiment-Speed control of a Stepper Motor.

Course Outcomes

At the end of the course, students will:
CO1: Conduct a experiments by applying the knowledge of basic science to study the characteristics of power semiconductor devices.
CO2: Conduct experiments to analyze power electronic circuits such as DC-DC ,AC-DC,DC-AC,AC-AC converter and its firing circuits.
CO3: Ability to communicate effectively in a team / as an individual to conduct experiments.

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 method of speed control of Universal motor
4. Analyze the basic operation of AC Voltage Controllers with various loads.
5. Analyze the basic operation of Half control bridge rectifier operation with various loads.
6. Analyze the basic operation of Full control bridge rectifier operation with various loads.
7. Analyze the basic operation of DC-DC Power conversion
8. Analyze the basic operation of different types of Commutation circuits.
9. Analyze the basic operation of Inverter using without firing circuits.

10. Analyze the basic operation of PWM-Inverter using firing circuits.
11. Analyze the basic operation of SCR turn on using synchronized UJT relaxation oscillator
12. Analyze the method of speed control of Stepper Motor

Course Articulation Matrix														
Course Outcomes:	**Program Outcomes:**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1 Conduct a experiments by applying the knowledge of basic science to study the characteristics of power semiconductor devices.	3	-	-	2	-	-	-	-	-	-	-	-	2	-
2 Conduct experiments to analyze power electronic circuits such as DC-DC ,AC-DC,DC-AC,AC-AC converter and its firing circuits.	-	3	-	3	-	-	-	-	-	-	-	-	-	3
3 Ability to communicate effectively in a team / as an individual to conduct experiments.	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1 – Low						**2 – Medium**							**3 – High**	

Course Title: ELECTRICAL MACHINES LAB –II			
Course Code:P18EEL57	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:
2. They will be able to study OCC and load characteristics of DC generator & DC Motor
3. They will be able study the different methods of speed control of DC motor
4. They will be able to determine the efficiency of machine both as generator and motor by conducting various tests.
5. They will know the working of synchronous Motor

List of Experiments

1. 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. DC Motor speed control using chopper circuit.
12. Self-study experiment

Course outcomes

The course enables the students to:

CO1: Conduct experiments to obtain performance characteristics of DC Machines.

CO2: Conduct experiments to obtain performance characteristics of Synchronous Machines.

CO3: Ability to communicate effectively in a team/as an individual to conduct experiments.

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
8. Study of DC motor using Chopper circuit.

Course Articulation Matrix														
Course Outcomes	**Program Outcomes**													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
Conduct experiments to obtain performance characteristics of DC Machines.	3	3	-	3	-	-	-	-	-	-	-	-	2	2
Conduct experiments to obtain performance characteristics of Synchronous Machines.	3	3	-	3	-	-	-	-	-	-	-	-	2	2
Ability to communicate effectively in a team/as an individual to conduct experiments.	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1 – Low					**2 – Medium**							**3 – High**		

Course Title: Skill Oriented Laboratory – I MATLAB & Simulink			
Course Code:P18EEL58	Semester: V	L-T-P-H(Hrs): 0-0-2-2	Credits – 1
Contact period : Lecture: 16Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50	

List of Experiments

MATLAB

1. Study of Introduction to MATLAB

2. Study of basic matrix operations

3. To solve linear equation

4. Solution of Linear equations for Underdetermined and Over determined cases.

5. Determination of Eigen values and Eigen vectors of a Square matrix.

6. Solution of Difference Equations.

7. Solution of Difference Equations using Euler Method.

8. Solution of differential equation using 4th order Runge- Kutta method.

9. Determination of roots of a polynomial.

10. Determination of polynomial using method of Least Square Curve Fitting.

11. Determination of polynomial fit, analyzing residuals, exponential fit and error bounds from the given data.

12. Determination of time response of an R-L-C circuit.

Simulink simscape

1. Creating a simple circuit

2. Determination of R, L & C Responses

3. Design of RC, RL, RLC Circuits

4. Design of Half wave and Full wave Rectifier Circuits.

5. Simulating Motor control Techniques

Course Articulation Matrix															
Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of mathematics to to solve different mathematical equation using MATLAB Programming .	3	2	-	-	3	-	-	-	-	-	-	-	2	-
2	Analyze different electrical circuits using MATLAB simulink	2	3	-	-	3	-	-	-	-	-	-	-	-	2
3	Ability to communicate effectively in a team/as an individual to conduct experiments.	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1 – Low						**2 – Medium**							**3 – High**		

Course Title: MATLAB PROGRAMING			
Course Code:P18EE591	Semester: V	L-T-P-H(Hrs): 0-2-0-2	Credits – 1
Contact period : Lecture: 25 Hrs, Exam 3 Hrs		Weightage: CIE:50SEE:50	

UNIT- I

Introduction to MATLAB: Basics of MATLAB-MATLAB windows online help, Input o/p, file types, Platform dependence, General commands.   **3Hrs**

UNIT – II

Interactive Computation

Matrices and vectors-Input, Indexing (or subscripting),Matrix manipulation ,Creating vectors, Matrix and Array Operations -Arithmetic operations, Relational operations ,Logical operations, Elementary math functions ,Matrix functions Character strings-Manipulating character strings, The eval function,A Special Note on Array Operations-Vectorization, Command Line Functions - Inline functions, Anonymous functions Using Built-in Functions and On-line Help-Example 1: Finding the determinant of a matrix,

Example 2: Finding eigenvalues and eigenvectors, Saving and Loading Data-Saving into and loading from the binary Mat-files, Importing data files, Recording a session with diary ,Plotting Simple Graphs   **4 Hrs**

UNIT – III

Programming in MATLAB:

Scripts and Functions-Script Files, Function Files- Executing a function, More on functions, M-Lint code analyzer, Subfunctions, Nested functions, Compiled (parsed) functions: The p-code, The profiler, Language-specific Features-Use of comments to create on-line help, Continuation ,Global variables, Loops, branches, and control-flow, Interactive input, Recursion, Input/output, Advanced Data Objects-Multidimensional matrices, Structure, Cells, Publishing Reports

                                                                                      6 Hrs

UNIT – IV

Applications:

Linear Algebra-Solving a linear system, Gaussian elimination, Finding eigenvalues and eigenvectors, Matrix factorization, Advanced topics, Curve Fitting and Interpolation, Polynomial curve fitting on the fly, Do it yourself: Curve fitting with polynomial function, Least squares curve fitting, General nonlinear fits, Interpolation, Data Analysis and Statistics, Numerical Integration (Quadrature),Double integration, Ordinary Differential Equations-Example 1: A first-order linear ODE ,Example 2: A second-order nonlinear ODE, Ode 23 versus Ode 45,Specifying tolerance, The ODE suite, Event location, Nonlinear Algebraic Equations, Roots of polynomials, Advanced Topics   -

                                                                                      6 Hrs

UNIT – V

Graphics

Basic 2-D Plots-Style options **,**Labels, title, legend, and other text objects**,** Axis control, zoom in, and zoom out**,** Modifying plots with the plot editor**,** Overlay plots**.** Specialized 2-D plot, Using

subplot for multiple graphs**,**3- D plots-View**,** Rotate view**,** Mesh and surface plots**,** Vector field and volumetric plots**,** Interpolated surface plots . **6Hrs**

Text book

1. Rudra prathap- Getting started with MATLAB, Oxford university press, Indian edition.

Ref. Book

1. Stephen J Chapman – programming in MATLAB for engineers, cengate learning, Indian edition.

<table>
<tr><th colspan="15">Course Articulation Matrix</th></tr>
<tr><th rowspan="2">Course Outcomes</th><th colspan="14">Program Outcomes</th></tr>
<tr><th>PO1</th><th>PO2</th><th>PO3</th><th>PO4</th><th>PO5</th><th>PO6</th><th>PO7</th><th>PO8</th><th>PO9</th><th>PO10</th><th>PO11</th><th>PO12</th><th>PSO1</th><th>PSO2</th></tr>
<tr><td>1 — Apply the knowledge of basic computers to study different MATLAB commands.</td><td>3</td><td>1</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td><td>-</td></tr>
<tr><td>2 — Analyze mathematical and logical operations using MATLAB.</td><td>2</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td>3 — Analyze the execution process using MATLAB Programming.</td><td>2</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td>4 — Develop MATLAB programs for different applications by understanding the basics.</td><td>2</td><td>3</td><td>-</td><td>-</td><td>2</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td>5 — Apply the knowledge of MATLAB to study different Plots.</td><td>3</td><td>-</td><td>-</td><td>-</td><td>2</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td></tr>
<tr><td colspan="15">**1 – Low**   **2 – Medium**   **3 – High**</td></tr>
</table>

Course Title: C ++ Programming			
Course Code:P18EE592	Semester: V	L-T-P-H(Hrs): 0-2-0-2	Credits – 1
Contact period : Lecture: 25 Hrs, Exam 3 Hrs		Weightage: CIE:50; SEE:50	

Unit-I

The basic Language C++: Comparison of C and C++, structure of C++ program with class, Pre-processor directives, C++ statements-input/output, comments, tokens, keywords, identifiers, constants, data types-string, pointer, reference, boole, enumeration, array, complex number, typed names, type compatibility, type conversion, qualifier-const, volatile; operators in C++, Operators Precedence and operator overloading; C++ expressions-New and Delete. **5Hrs**

Unit-II

Functions in C++: introduction, main( ) function, Function prototype, Call by reference, Return by reference, Inline functions, default arguments, Const Arguments, function overloading, Friend and virtual functions, Pointer to functions. **5Hrs**

Unit-III

Objects: Objects-global and local objects, scope and lifetime, Memory allocation for objects,<dynamically allocated objects, pointers to objects, Arrays of objects, Function arguments withobjects, returning objects; const member functions. **5Hrs**

Unit-IV

Operator overloading and type conversion: Introduction, Defining operators, Overloading unary operators, overloading binary operators, overloading binary operators, overloading the output operator<, overloading the input operator>>, type conversion. **5Hrs**

Unit-V

Pointer, Virtual Functions and Polymorphism: Introduction, Pointers, Pointers to objects this pointer, Pointers to derived classes, type-checking pointers, pointers to members, Virtual functions, pure virtual functions. **5Hrs**

Text Book:
1. Balagurusamy, "Object Oriented Programming with C++", TMH, 3rd edition, 2007.

Reference Books:
1. Herbert Schildt, "C++, The Complete Reference", TMH,3rd edition,2007
2. BjarneStroustrup, "The C++ programming language", Pearson education, 3rd edition,2007

Course Title: Software Engineering			
Course Code:P18EE593	Semester: V	L-T-P-H(Hrs): 0-2-0-2	Credits – 1
Contact period : Lecture: 25 Hrs, 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.
.   **5 Hrs**

Unit – II

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

5 Hrs

Unit – III

System modeling: Context models, Interaction models, Structural models, Behavioral models, Model-driven engineering, Architectural design decisions, Architectural views, Application architectures

5 Hrs

Unit – IV

Software testing: Development testing, Test-driven development, Release testing, Open source development, User testing.
.   **5 Hrs**

Unit – V

Project management: Risk management, Managing people, Teamwork.
Configuration management: Change management, Version management System building.

5Hrs

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: Hybrid Electric Vehicles			
Course Code:P18EE594	Semester: V	L-T-P-H(Hrs): 0-2-0-2	Credits – 1
Contact period : Lecture: 25 Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50	

Unit-I

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

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

Unit-II

Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs, Vehicle-to-Grid Technology. **5 Hrs**

Unit-III

Power Electronics in HEVs: Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Modelling and Simulation of HEV Power Electronics, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics. **5 Hrs**

Unit-IV

Electric Machines and Drives in HEVs: Introduction, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modeling of Traction Motors.   **5 Hrs**

Unit-V

Batteries, Ultra capacitors, Fuel Cells, and Controls: Introduction, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Modelling Based on Equivalent Electric Circuits, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System.
5 Hrs
Text Book:
1.Hybrid Electric Vehicles principles and Applications with Practical Perspectives Chris Mi.M AbulMasrur, Davi D Wenzhog Gao

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of basic science to study components of HEV's	3	1											2	-
2	Examine the architecture and power technologies of Plug-in EVs	2	3											-	2
3	Analyze the various power converters used in PHEV's	2	3												2
4	Analyze the various machines used in PHEV's	2	3												2
5	Examine the types of batteries used in PHEVs.	2	3												2

1 – Low **2 – Medium** **3 – High**

Course Title: Aptitude and Reasoning Development - Advance (ARDI)			
Course Code:P18HU510	Semester: V	L-T-P-H(Hrs): 0-0-2	Credits – 1
Contact period : Lecture: 32 Hrs, Exam 3 Hrs		Weightage: CIE:50; SEE:50	

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.   **8hr**

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

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**.**   **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

4 Hrs

Unit V

Coding Decoding: Letter Coding, Number Coding, symbol coding

Crypt arithmetic: Basic concepts , addition **,** subtraction, multiplication of coded alphabets,Types of cryptarithm

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 **8 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.

Electrical and Electronics Engineering

VI SEMESTER

Course Title: POWER SYSTEM ANALYSIS & STABILITY			
Course Code:P18EE61	Semester: VI	L-T-P-H(Hrs): 4-0-0-4	Credits –4
Contact period : Lecture: 52Hrs, 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 impedance/reactance diagrams of power systems. Illustrative examples.

Self-Study: Per unit system- merits and demerits.   **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, Illustrative examples.

Self-Study: Selection of circuit breakers   **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, Positive, Negative and Zero sequence networks of power system elements. Illustrative examples.

Self-Study: Sequence impedance of power system elements (alternator, transformer and transmission line).   **11Hrs**

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. **11Hrs**
Self-Study: Open conductor faults in power systems (No numerical problems, only theory).

Unit-V

Stability Studies: Steady state and transient stability, Steady state and transient stability limits. Power angle equation, Rotor dynamics and Swing equation. Illustrative examples.
Self-Study: Equal area Criterion for stability. **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: Apply circuit models to obtain per unit reactance diagram of power system
CO2: Analysis of symmetrical faults for different conditions.
CO3: Examine different sequence network using symmetrical components.
CO4: Analyzing unsymmetrical faults under various conditions.
CO5: Evaluate steady state and transient state stability of power system.

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply circuit models to obtain per unit reactance diagram of power system	3	3	-	-	-	-	-	-	-	-	-	-	2	-
2	Analysis of symmetrical faults for different conditions.	3	3	-	-	-	-	-	-	-	-	-	-	2	
3	Examine different sequence network using symmetrical components.	3	3	-	-	-	-	-	-	-	-	-	-	2	
4	Analyzing unsymmetrical faults under various conditions.	3	3	-	-	2	-	-	-	-	-	-	-	2	
5	Evaluate steady state and transient state stability of power system.	3	3	-	-	-	-	-	-	-	-	-	-	2	
1 – Low						**2 – Medium**								**3 – High**	

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 reactance.
8. Explain how fault current is obtained from calculating the sub transient reactance and from the internal voltages
9. Explain how fault current is obtained by using Theviens equivalent circuits from the sub transient reactance 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 reactance 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. Reactance 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.

Electrical and Electronics Engineering

Course Title: DIGITAL SIGNAL PROCESSING			
Course Code:P18EE62	Semester: VI	L-T-P-H(Hrs): 3-2-0-5	Credits –4
Contact period : Lecture: 52Hrs, 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), Inverse DFT (IDFT) and properties of DFT.
2. Understand and use the FFT algorithms and its applications
3. Carry out the design and implementation of IIR filters and FIR filters
4. Understand basics of DSP processor and its applications

Course Content

Unit – I

Discrete Fourier transforms (DFT):

Introduction, definitions of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier transform (IDFT).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   **10Hrs**

Self-Study: Relation between DFT and DFS.

Unit – II

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.   **11Hrs**

Self-Study: To implement FFT and IFFT Algorithms using MATLAB

Unit – III

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
Self-study: Lattice structure for FIR and IIR systems.

Unit –IV

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 and modified rectangular window   **11Hrs**

Self-study: Design of Chebyshev Filter, Hanning window, Blackman window

UNIT-V

Introduction to digital signal processor: Features, TMS320C5X DSP processors – features architectures, applications – speech encoding & modem communication, servo control using TMS320 processors, video signal processing. Comparison between DSP processor and general purpose processor.   **10 Hrs**

Self-study: Special addressing modes and on chip peripherals

<u>**Text books:**</u>

1. Proakis, "Digital Signal Processing - Principle, Algorithms & Applications", 3rd edition, Pearson Education / PHI , 2013.
2. J.S.Chitode , "Digital Signal Processing" - Technical publications. Pune. 2013

<u>**Reference books:**</u>

1. Dr. D Ganesh Rao & Vineeta P. Gejji , "Digital Signal Processing", Sanguine Technical Publishers, 2013.

<u>Course Outcomes</u>

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

CO1: Apply the knowledge of DFT and FFT in its various applications

CO2: Analyze the transformation of digital signals into the frequency domain using FFT/DFT methods.

CO3: Examine the transformation of digital signals into the frequency domain using FFT/DFT methods.

CO4: Design and Implementation of IIR filters using Bilinear Transformation.

CO5: Apply the knowledge of DSP Processor and its applications.

	Course Articulation Matrix														
		Program Outcome													
	Course Outcome – CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of DFT and FFT in its various applications	3	3	-	-	-	-	-	-	-	-	-	-		2
2	Analyze the transformation of digital signals into the frequency domain using FFT/DFT methods.	3	3	-	-	-	-	-	-	-	-	-	-	-	2
3	Examine the transformation of digital signals into the frequency domain using FFT/DFT methods.	3	3	-	-	-	-	-	-	-	-	-	-	-	2
4	Design and Implementation of IIR filters using Bilinear Transformation	3	3	1	-	-	-	-	-	-	-	-	-	-	2
5	Apply the knowledge of DSP Processor and its applications	3	3	-	-	-	-	-	-	-	-	-	-	-	2
	1 – Low					**2 – Medium**							**3 – High**		

Topic Learning Objectives

After learning all the topics of unit-I, the student is able to
1. Explain concept of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier transform (IDFT) for the frequency domain transformations
2. Solve problems by matrix relations for computing DFT and IDFT
3. Apply the knowledge of various properties of DFT
4. Apply Various Symmetry Properties
5. Determine DFT of real even and real odd sequences
6. Determine DFT of complex conjugate sequence
7. Understanding N-point DFTs of two real sequences using a Single N-point DFT

After learning all the topics of unit-II, 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-III, 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-IV, 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

After learning all the topics of unit-V, the student is able to
1. Understanding the features of DSP Processors
2. Analyze the architecture of TMS320C5x Processors
3. Analyze the applications of TMS320C5x Processors
4. Compare DSP Processors with general purpose Processors

Review Questions
1. Give the definitions of DFT and IDFT.
2. Find the N-point DFT of the given sequence x(t).
3. Show that the DFT and IDFT form a consistent discrete Fourier transform pairs.
4. State properties of DFT
5. State and prove the following properties of the DFT. (i) Circular time reversal (ii) Circular time shift (iii) Circular frequency shift
6. Explain circular convolution
7. What is difference between circular convolution and Linear convolution.
8. Prove that the DFT of a real and even sequence is purely real and even.

9. Prove the time shifting property of DFT
10. In the direct computation of N-point DFT of a sequence, how many multiplications, additions and trigonometric function evaluation are required?
11. What is FFT?
12. Give the classification of various FFT algorithms
13. Explain radix -2 DIT-FFT algorithm. Explain how calculations are reduced.
14. Develop an 8-point DIT-FFT
15. Compare DIF-FFT algorithm with DIT-FFT algorithm
16. Use 8-point DIF-FFT radix- 2 algorithm to find the DFT of the given sequence x(n)
17. Write the short notes on the following: (i) Butterfly computation.(ii) Inplace computation (iii) bit reversal
18. Calculate the IDFT of the given X(k) , using inverse radix-2 DIT-FFT algorithm
19. Explain the implementation of FIR filters using direct form and cascaded form realizations.
20. Explain linear phase FIR structures. What are the advantages of such structures?
21. Realize a linear phase FIR filter with given impulse response h(n).
22. Realize the FIR filter (i) direct form (ii) Cascaded form for the given transfer function H(z).
23. Explain the Direct form-I and Direct form-II structure of IIR system
24. Obtain the cascade and parallel form for the given H(z).
25. What is transposed structure, explain with suitable example.
26. Compare the main features of analog and digital filters.
27. Explain the frequency transformations in analog domain
28. Explain the frequency transformations in digital domain
29. Explain in detail Butterworth filter approximation.
30. Explain the design of analog Butterworth low pass IIR filter.
31. Explain "impulse invariant technique" of designing digital –IIR filter with a relevant example.
32. Explain the bilinear transform method of IIR filter designing.
33. What is warping effect? Explain the poles and zeros mapping procedure clearly.
34. Compare impulse invariance and bilinear transformation methods.
35. Mention the properties of FIR digital filters. State their importance.
36. Derive the necessary conditions for FIR filters to have linear phase characteristics.
37. 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
38. Explain the features of DSP Processors
39. Explain the architecture of TMS320C5x DSP Processors
40. Give the comparison between DSP and general Processors

Lesson Plan
Unit-I

1. Introduction to Digital Signal Processing
2. Definition of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier transform (IDFT)
3. Solve the problems to find DFT/IDFT
4. Explanation of properties of DFT: Linearity, circular time shift and circular frequency shift
5. Symmetry Properties
6. DFT of real even and real odd sequences
7. DFT of complex conjugate sequence
8. Circular Convolution
9. Problems based on Circular Convolution
10. Time reversal of sequences,
11. Numerical Problems

Unit-II

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-III

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-IV

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, Illustrative examples

Unit-V

1. Introduction to DSP Processor
2. Features of DSP Processor
3. Architecture of TMS320C5x Processor
4. Features of TMS320C5x Processor
5. Applications of Speech encoding and modem communication using TMS320C5x Processor
6. Applications of Servo control using TMS320C5x Processor
7. Applications of Video signal processing using TMS320C5x Processor
8. Comparison of DSP and general purpose Processor

Course Title: ELECTRICAL MACHINE DESIGN			
Course Code:P18EE63	Semester: VI	L-T-P-H(Hrs): 3-1-0-4	Credits –4
Contact period : Lecture: 52Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50	

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.

Self-Study: Constructional features of DC machines.   **11Hrs**

Unit – II

DESIGN OF DC MACHINES: Design of armature slot dimensions, Commutator and brushes, Design of yoke and pole, Field windings-shunt & series.

Self-Study: Magnetic circuit- estimation of ampere turns   **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).

Self-Study: Methods of cooling of Transformers   **11Hrs**

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.

Self-Study: 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.

Self-Study: Design of Turbo alternators   **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: Design of armature diameter and core length of DC machine with the knowledge of material properties.

CO2: Design of armature and commutator of a DC machine.

CO3: Design of Single and three phase transformer

CO4: Design of Induction motors.

CO5: Design of Synchronous machines.

Course Articulation Matrix															
Course Outcomes – CO		**Program Outcomes**													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12	PS O1	PSO 2
1	Design of armature diameter and core length of DC machine with the knowledge of material properties	2	2	3	-	-	-	-	-	-	-	-	-	-	2
2	Design of armature and commutator of a DC machine.	2	2	3	-	-	-	-	-	-	-	-	-	-	2
3	Design of Single and three phase transformer	2	2	3	-	-	-	-	-	-	-	-	-	-	2
4	Design of Induction motors.	2	2	3	-	-	-	-	-	-	-	-	-	-	2
5	Design of Synchronous machines.	2	2	3	-	-	-	-	-	-	-	-	-	-	2
1 – Low						**2 – Medium**						**3 – High**			

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 Title: SWITCHGEAR AND PROTECTION			
Course Code:P18EE641	Semester: VI	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, 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, 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, Rating of circuit breakers.   **08Hrs**

Self-study: Liquid fuse and its applications

Unit-II

CIRCUIT BREAKERS:

Air Circuit breakers – air break and air blast circuit breakers, **SF$_6$ breaker** - preparation of SF$_6$ gas, puffer and non-puffer type of SF$_6$ breakers. GIS and its advantages.

Vacuum circuit breakers - Construction, Principle of operation, Advantages and disadvantages of different types of circuit breakers, Short circuit test lay out

Self-study: Operation of MCB, ELCB and its applications   **08Hrs**

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,

Self-study: Operation of Mhorelay,   **08Hrs**

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

Self-study: Bus bar protection   **08Hrs**

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, over load protection: Phase reversal Protection

Self-study: Protection against lightning   **08Hrs**

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: Apply the knowledge of basic electrical to analyze the operation of fuse, switches and circuit breaker operations.

CO2: Analyze the various types of circuit breakers

CO3: Analyze the characteristic of different relays and selection criteria

CO4: Examine the different protection scheme for Generator.

CO5: Describe the different protection schemes for transformers and induction motors.

Course Articulation Matrix														
Course Outcomes		**Program Outcomes**												
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12	PSO1	PSO2
1	Analyze the operation of fuse, switches and circuit breaker operations.	2	3	-	-	-	2	-	-	-	-	-	-	2	-
2	Analyze the various types of circuit breakers	2	3	-	-	-	2	-	-	-	-	-	-	2	
3	Analyze the characteristic of different relays and selection criteria	2	3	-	-	-	2	-	-	-	-	-	-	2	
4	Examine the different protection scheme for Generator.	2	3	-	-	-	2	-	-	-	-	-	-	2	
5	Describe the different protection schemes for transformers and induction motors.	2	3	-	-	-	2	-	-	-	-	-	-	2	
1 – Low						**2 – Medium**							**3 – High**		

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 Title: MODERN CONTROL THEORY			
Course Code:P18EE642	Semester: VI	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50	

Course learning objectives

Students will be able to:

1. Get the knowledge of various industrial automatic controllers such as P, I, D, PI, PD & PID controllers and compensating networks.
2. Understand modeling in state space for different systems and analyze the state space representation using different canonical forms.
3. Get the knowledge of solution of linear time invariant systems, state transition matrix, determination of state transition matrix using various techniques and analyze the controllability and observability of the system.
4. Understand the basics of design of control system by pole placement technique, necessary & sufficient conditions for the design, determination of state feedback gain matrix using various methods and observer design.
5. Analyze the stability of the linear system based on liapunov stability criterion, construction of liapunov functions for nonlinear system by krasovkii's method.

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)   **08Hrs**

Self-study: Compensation using root locus technique.

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.

State space representations of transfer function systems: Canonical forms- Controllable, observable, and diagonal, Jordan canonical forms, Eigen values, diagonalisation, invariance of Eigen values.   **08Hrs**

Self-study: linearization of state equation, state model by cascade programming.

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.   **08Hrs**

Self-study: Linear independence of vectors, Principle of Duality

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.   **08Hrs**

Self-study: Design of Minimum order and reduced order state observer.

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.   **08Hrs**

Self-study: Liapunov stability analysis of nonlinear systems.

Text Books:

1. KatshuikoOgata"Modern Control Engineering", - 3rdedition 2002 & 5th Edition, 2012, PHI.
2. 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 Outcomes

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

CO1: Analyze the different types of industrial automatic controllers and compensation circuits..

CO2: Model the control system using state space.

CO3: Solution of the linear time invariant state equation and discuss the concept of controllability and observability.

CO4: Design of control system in state space

CO5: Analyze the Liapnov stability

Course Articulation Matrix														
Course Outcomes	**Program Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Analyze the different types of industrial automatic controllers and compensation circuits.	3	2	-	-	-	-	-	-	-	-	-	-	-	1
Model the control system using state space	3	2	-	-	-	-	-	-	-	-	-	-	-	1
Solution of the linear time invariant state equation and discuss the concept of controllability and observability.	3	2	-	-	-	-	-	-	-	-	-	-	-	1
Design of control system in state space	3	3	2	-	-	-	-	-	-	-	-	-	-	2
Analyze the Liapnov stability.	3	2	-	-	-	-	-	-	-	-	-	-	-	1
1 – Low				**2 – Medium**							**3 – High**			

Course Title:EMBEDDED SYSTEMS		
Course Code:P18EE643	Semester: VI	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, Exam 3 Hrs		Weightage: CIE:50 SEE:50

Course Learning Objectives (CLOs)

This course aims is to:

1. Understand the applications, purpose and design challenges of Embedded System

2. Learn about selecting a processor and applications of embedded system in various fields.

3. Understand the different types of memories and protocols used in Embedded System

4. Learn about design issues and different models used in Embedded System

5. Get the basic knowledge of Real time operating systems and interrupts

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.
Self-study: Microprocessors vs microcontrollers   **08 Hrs**

UNIT-II

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

08 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.
Self-study: Arbitration   **08 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.

Self-study: The UML Tools   **08 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.

Self-study: Interrupt routines in an RTOS environment

08 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 Outcomes

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

CO1: Apply the knowledge of microcontroller to describe the applications and design challenges of Embedded System

CO2: Analyze the selection of processor and applications of Embedded System in various fields.

CO3: Examine different types of memories and protocols used in Embedded System

CO4: Analyze the design issues and different models used in Embedded System

CO5: Analyze the different issues involved in Embedded system development using RTOS.

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Course Articulation Matrix															
	Course Outcomes	Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of microcontroller to describe the applications and design challenges of Embedded System	2	2	-	-	-	-	-	-	-	-	-	-		
2	Analyze the selection of processor and applications of Embedded System in various fields.	2	3	-	-	-	-	-	-	-	-	-	-		
3	Examine different types of memories and protocols used in Embedded System.	2	3	-	-	-	-	-	-	-	-	-	-		
4	Analyze the design issues for different models and develop an Embedded System.	2	3	1	-	2	-	1	2	2	2	2	2		
5	Analyze the different issues involved in Embedded system development using RTOS	2	3	-	-	-	-	-	-	-	-	-	-		
1 – Low						**2 – Medium**							**3 – High**		

Course Title: PROGRAMMABLE LOGIC CONTROLLER & SCADA			
Course Code:P18EE644	Semester: VI	L-T-P-H(Hrs): 2-2-0-4	Credits –3
Contact period : Lecture: 40Hrs, 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)
Self-study: List the forms and specifications of PLCs available from various manufacturers
08Hrs

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
Self-study: Examples of Commercial Network systems   **08Hrs**

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
Self-study: Master control internal relay   **08Hrs**

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
Self-study: retentive timer, Timer/counter sequencer   **08Hrs**

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.
Self-study: case study of a real time SCADA Application   **08Hrs**

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,
3. An Industrial text company publication,1997.

Course Outcomes

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

CO1: Examine the hardware, standards, I/O devices of programmable logic controllers & its applications

CO2: Analysis of input and output unit and its connection with PLC.

CO3: Discuss various programming techniques of PLC

CO4: Analyzing Timers, Counters and shift registers programming in PLC

CO5: Illustrate data handling instructions of PLC & discover the basics of SCADA System

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Examine the hardware, standards, I/O devices of programmable logic controllers & its applications	2	3	-	-	-	-	-	-	-	-	-	-	-	-
2	Analysis of input and output unit and its connection with PLC	2	3	-	-	-	-	-	-	-	-	-	-	-	-
3	Discuss various programming techniques of PLC	2	2	-	-	-	-	-	-	-	-	-	-	-	-
4	Analyzing Timers, Counters and shift registers programming in PLC	2	3	-	-	-	-	-	-	-	-	-	-	-	-
5	Illustrate data handling instructions of PLC & discover the basics of SCADA System	2	3	-	-	-	-	-	-	-	-	-	-	-	-
1 – Low					**2 – Medium**							**3 – High**			

Course Title: Power Plant Engineering			
Course Code : P18EEO651	Semester : VI	L-T-P-H(Hrs): 3-0-0-3	Credits – 3
Contact Period: Lecture: 40 Hr. Exam 3 Hr		Weightage: CIE:50 SEE:50	

Course Learning Objectives (CLOs)

1. Understand the conceptual working principles of conventional sources of electric power generation.
2. Explain the detail description of hydroelectric plants, nuclear power plants and gas power plants.
3. Analyze the power generation using non-conventional energy sources
4. Understand the concept of load curves and different tariff
5. Understand the concept grounding and power factor

Unit – I

Hydro Electric Power Generation: Selection of site, Classification of site, General arrangement and operation. Power station structure & control.
Thermal Power Generation: Introduction, Main parts, Working, Plant layout, Coal handling system, Ash disposal schemes.   **8Hrs**
Self-study: Principle of working of a Hydro – Electric Turbines

Unit – II

Nuclear Power Station: Introduction, Selection of site, Cost, Components, Reactors, Description of fuel sources, Adverse effects, Safety of nuclear power station, Disposal schemes of nuclear waste.
Diesel Electric Station: Introduction, Types of plants, Components, Plant layout and maintenance, Choice and characteristics   **8Hrs**
Self-study: Nuclear materials

Unit – III

Generation Using Non-Conventional Energy Sources: Solar, Wind, Tidal, Geo-thermal
Co-Generation: Mini, Micro and Bio fuel Generation, Distributed generation.   **8Hrs**
Self-study: Gas turbine plants

Unit – IV

Economic Aspects: Introduction, Terms commonly used in system operations: Diversity factor, Load factor, Plant capacity factor, Plant use factor, Plant utilization factor, Loss factor. Load duration curve, Power factor improvement and Tariffs.   **8Hrs**
Self-study: Load curve and load duration curve and its uses

Unit – V

Interconnected stations: necessity of phase angle control, load sharing and transfer of load between stations, Power limit of interconnectors.
Grounding Systems: Introduction, Resistance grounding system, Neutral grounding, ungrounded system, Resonant grounding, Solid grounding, Reactance grounding, Earthing transformer, Neutral grounding transformer.   **8Hrs**
Self-study: Parallel operation of interconnector

Text Book:

1. S. M. Singh, "Electrical power generation, transmission and distribution"-Prentice hall of India, New Delhi, 2nd 2008.

2.Chakrabarti, M-L Soni, P.V. Gupta, U.S. Bhatnagar, "Power system Engineering", Dhanpat Rai& Co., 2001.

Reference Books:

1.M.V. Deshapande, "Electrical Power System Design" T.M.H., 1993.

2. C.L. Wadwa, "Electrical Power System", Wiley Stern.2000.

Course Out Comes

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

CO1: Analyze the concept of hydro and thermal power plants.
CO2: Explain the descriptions of nuclear and diesel power plants
CO3: Describe the power generation method based on non- conventional and co-generation.
CO4: Examine the economic aspects of power generation and distribution system.
CO5: Discuss the concept of interconnecting stations and different grounding methods.

Course Articulation Matrix															
Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Analyze the concept of hydro and thermal power plants.	3	2	-	-	-	-	-	-	-	-			3	
2	Explain the descriptions of nuclear and diesel power plants	3	2	-	-	-	-	-	-	-	-			3	
3	Describe the power generation method based on non- conventional and co-generation.	3	2	-	-	-	-	-	-	-	-			3	
4	Examine the economic aspects of power generation and distribution system.	3	2	-	-	-	-	-	-	-	-			2	
5	Discuss the concept of interconnecting stations and different grounding methods.	3	2	-	-	-	-	-	-	-	-			2	
1-Low				**2-Medium**								**3-High**			

Electrical and Electronics Engineering

Course Title: ILLUMINATION ENGINEERING			
Course Code:P18EEO652	Semester: VI	L-T-P-H(Hrs): 3-0-0-3	Credits –3
Contact period : Lecture: 40Hrs, Exam 3 Hrs		Weightage : CIE:50 SEE:50	

Course Learning Objectives (CLOs)

This course is aim is to

1. Understand the different sources and energy radiation of lights
2. Understand the different measuring types and types of lights
3. Understand the different lighting parameters and design of luminance

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, Theory of gas discharge and production of light.   **8Hrs**
Self-study: Dependence of light output on temperature

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.   **8Hrs**
Self-study: Measurement of colour.

Unit – III

Types of lamps: GLS, Tungsten - halogen, Discharge, low pressure sodium vapour fluorescent, metal - halide, IR and VV lamps - their construction, filament material, theory of operation, life, characteristics.   **08 Hrs**
Self-study: Applications of various lamps

Unit – IV
Design, objectives and specifications of lighting and systems: Design of luminance, basic lighting design, consideration and lighting parameters for extension lighting, interior lighting and day lighting.   **08 Hrs**
Self-study: Electrical circuits and auxiliaries

Unit – V
Energy conservation in lighting: Perception of light and colour, optical system of human eye, eye as visual processor. Reflection, refraction.   **08 Hrs**
Self-study: Behaviour of light

Text Book:
3. Wadha C L: Utilization of Electric Power - New Age International LtdEdition 2011.
4. Wadha C L: Generation, Distribution and Utilization of electrical energy - New Age International Ltd, Edition 2011.

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

Course Title: : Fuzzy Logic Control			
Course Code : P18EEO653	Semester : VII	L-T-P-H: 3-0-0-3	Credits: 3
Contact Period: Lecture: 40 Hr. Exam 3 Hr		Weightage: CIE:50 SEE:50;	

Course Learning Objectives (CLOs)

This course aims is to:

1. To understand the properties and relations of fuzzy sets

2. To get the knowledge of different methods of membership function.

3. To study different variables and rules of fuzzy system

4. To understand the operations of fuzzy logic control system

5. To study the different rules, membership functions used in fuzzy knowledge based controllers

Course content
Unit-I

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.

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

Self-Study: Obtain the Examples of fuzzy sets for different engineering applications. **08 Hrs**

Unit-II

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.

Self-Study: Write MATLAB programs for the different Fuzzification, and Defuzzification methods **08Hrs**

Unit-III

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

Self-Study: Detailed study and make Comparisonsbetween Mamdani and Sugino methods.

08Hrs

Unit-IV

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.
Self-Study: Applications of FLC systems.   **08Hrs**

Unit-V

Fuzzy knowledge based controllers (FKBC): Basic concept structure of FKBC, Choice of Membership Functions, Scaling Factors, Rules, Fuzzyfication and Defuzzyfication Procedures.
Self-Study: Simple Applications of FKBC**.**   **08Hrs**

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

Reference books:
1. Fuzzy Sets Uncertainty and Information- G. J. Klir and T. A. Folger, PHI IEEE, 2009.
2. Essentials of Fuzzy Modeling and Control, R. R. Yaser and D. P. Filer,John Wiley, 2007.
3. Fuzzy Logic Intelligence Control And Information, Yen- Pearson education, First Edition,2006.

Course Title: : Estimation and Costing			
Course Code : P18EEO654	Semester : VII	L-T-P-H: 3-0-0-3	Credits: 3
Contact Period: Lecture: 40 Hr. Exam 3 Hr		Weightage: CIE:50; SEE:50;	

Course Learning Objectives:

1. To discuss the purpose of estimation and costing.
2. To discuss market survey, estimates, purchase enquiries, tenders, comparative statement and payment of bills and Indian electricity act and some of the rules
3. To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses.
4. To discuss design of lighting points and its number, total load, sub-circuits, size of conductor.
5. To discuss different types of service mains and estimation of power circuits.
6. To discuss estimation of overhead transmission and distribution system and its components.
7. To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation.

Unit-I

Principles of Estimation: Introduction to Estimation and Costing, Electrical Schedule, Catalogues, Market Survey and Source Selection, Recording of Estimates, Determination of Required Quantity of Material, Labour Conditions, Determination of Cost Material and Labour, Contingencies, Overhead Charges, Profit, Purchase System, Purchase Enquiry and Selection of Appropriate Purchase Mode, Comparative Statement, Purchase Orders, Payment Of Bills, Tender Form, General Idea about IE Rule, Indian Electricity(IE) Act.
Self-study: IE Rules -29,30,45,46,47,50,51,54,55,77 and79. **08Hrs**

Unit-II

Wiring: Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring. Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables Wiring (continued): Main Switch and Distribution Board, Conduits and its accessories and Fittings. Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse Units, Earthing Conductor. Internal Wiring: General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the Text Book), Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout.
Self-study: Single line diagram of wiring **08Hrs**

Unit-III

Service Mains: Introduction, Types, Estimation of Underground and Overhead Service Connections. Design and Estimation of Power Circuits: Introduction, Important Considerations

Regarding Motor Installation Wiring, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter
Self-study: different types of cables   **08Hrs**

Unit-IV

Estimation of Overhead Transmission and Distribution Lines (continued)**:** Repairing and Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to Insulator s, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead Lines, Clearances of Conductor from Ground, Spacing between Conductors, Important Specifications.
Self-study: types of insulators   **08Hrs**

Unit-V

Estimation of Substations: Main Electrical connection, Graphical Symbols for Various Types of Apparatus and Circuit Elements on Substation main Connection Diagram, Single Line Diagram of Typical Substations, and Equipment for Substation, Substation Auxiliaries Supply, Substation Earthing
Self-study: Lightning arrestors   **08Hrs**

Text Book: 1.A Course in Electrical Installation Estimating and Costing J. B. Gupta Katson Books, 9 th Edition, 2012

Electrical and Electronics Engineering

Course Title: CONTROL SYSTEMS AND DSP LABORATORY			
Course Code:P18EEL66	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

Control system Lab:

1. To determine the step response of second order system and its analysis using, Matlab.
2. Study the Compensating networks viz., Lag, Lead and Lag- lead compensating networks. Analyze using Matlab.
3. Study the effect of P, PI, PD and PID controller and their analysis using Matlab.
4. Draw the speed – torque characteristic of a two - phase A.C. servomotor and D.C. servomotor.
5. Draw the Root locus and Bode for the given transfer function using Matlab.

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

CO1: Conduct experiment to analyze characteristics of servomotors, time response of RLC circuit, performance of PID controllers and compensating circuits.

CO2: Execute the MATLAB programs to analyze stability of control system and DSP techniques.

CO3: Ability to communicate effectively in a team / as an individual to conduct experiments.

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Conduct experiment to analyze characteristics of servomotors, time response of RLC circuit, performance of PID controllers and compensating circuits.	3	3	-	3	-	-	-	-	-	-	-	-	2	-
2	Execute the MATLAB programs to analyze stability of control system and DSP techniques.	2	3	-	-	3	-	-	-	-	-	-	-	-	3
3	Ability to communicate effectively in a team / as an individual to conduct experiments.	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1 – Low						**2 – Medium**							**3 – High**		

Course Title:ELECTRICAL AUTO CAD			
Course Code:P18EEL67	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: Construct the single line diagram for various power systems, the Winding diagram for AC-DC Machines using AutoCAD
CO2: Apply the knowledge of Electrical machines to design transformers using AutoCAD
CO3: Ability to communicate effectively in a team / as an individual to conduct experiments.

Topic learning Objectives (TLOs):

1. To analyze and to draw the single line diagram of stations.
2. To analyze 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 machine**s**, 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

<table>
<tr><td colspan="16">Course Articulation Matrix (CAM)</td></tr>
<tr><td colspan="2" rowspan="2">Course Outcomes</td><td colspan="14">Program Outcomes</td></tr>
<tr><td>PO1</td><td>PO2</td><td>PO3</td><td>PO4</td><td>PO5</td><td>PO6</td><td>PO7</td><td>PO8</td><td>PO9</td><td>PO10</td><td>PO11</td><td>PO12</td><td>PSO1</td><td>PSO2</td></tr>
<tr><td>1</td><td>Construct the single line diagram for various power systems, the Winding diagram for AC-DC Machines using AutoCAD</td><td>3</td><td>3</td><td>-</td><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td><td>-</td></tr>
<tr><td>2</td><td>Apply the knowledge of Electrical machines to design transformers using AutoCAD</td><td>3</td><td>2</td><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2</td><td>2</td></tr>
<tr><td>3</td><td>Ability to communicate effectively in a team / as an individual to conduct experiments.</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>1</td><td>3</td><td>3</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="6">1 – Low</td><td colspan="5">2 – Medium</td><td colspan="5">3 – High</td></tr>
</table>

Course Title:Skill Oriented Laboratory-II Lab VIEW& Multisim			
Course Code:P18EEL67	**Semester: VI**	**L-T-P-H(Hrs): 0-0-2-2**	**Credits –1**
Contact period : Lecture: 16Hrs, Exam 3 Hrs		**Weightage: CIE:50 SEE:50**	

LABVIEW

1. Getting Started with LabVIEW: Creating an example to learn While Loops, Plotting, SubVIs, Case Structures, Arrays.

2. Mathematical operations in Labview

3. Logical Operation in LabView

4. Programming of Data Logging and Monitoring in LabVIEW

5. LabView Simple application Designing

MULTISIM

1. Basic Circuit: Design of RLC Circuit Multisim

2. Diode: Half and full adder design

3. Transistor: Design of amplifier circuit

4. Opamp: Design of Inverting and Non-Inverting Circuits

4. Design of Filters

5. Self-learning Project

Course Outcomes

CO1: Simulate mathematical model, logical model and Data-flow models by using LabVIEW.

CO2: Analyze the performance of adders, amplifiers, and filters by using Multisim.

CO3: Ability to communicate effectively in a team / as an individual to conduct experiments.

Course Articulation Matrix (CAM)														
Course Outcomes:	**Program Outcomes:**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Simulate mathematical model, logical model and Data-flow models by using LabVIEW	3	3	-	-	3	-	-	-	-	-	-	-	2	-
Analyze the performance of adders, amplifiers, and filters by using Multisim.	3	3	3	-	3	-	-	-	-	-	-	-	2	2
Ability to communicate effectively in a team / as an individual to conduct experiments.	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1 – Low					**2 – Medium**									**3 – High**