SYLLABUS

(With effect from 2023 -24)

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Bachelor Degree

In

Electrical and Electronics Engineering

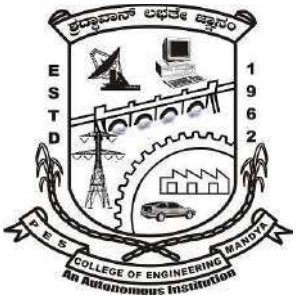
V &VI Semester

Outcome Based Education

With

Choice Based Credit System

[National Education Policy Scheme]



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

[An Autonomous Institution affiliated to VTU, Belagavi,
Grant – in – Aid Institution (Government of Karnataka),
Accredited by NBA (All UG Programs), NAAC and Approved by AICTE, New Delhi]

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

VISION

"PESCE shall be a leading institution imparting quality Engineering and Management education developing creative and socially responsible professionals."

MISSION

- *Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.*
- *Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.*
- *Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.*
- *Promote research, product development and industry-institution interaction.*

QUALITY POLICY

Highly committed in providing quality, concurrent technical education and continuously striving to meet expectations of stake holders.

CORE VALUES

***P**rofessionalism*

***E**mpathy*

***S**ynergy*

***C**ommitment*

***E**thics*

DEPARTMENT OF ELECTRICAL AND 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 . More than 100 research papers have been published by the Department faculty members in various International & National journals and conferences.

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

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

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

VISION

The department of E & E would endeavor 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 instil team skills.
- MOUs and Sponsored projects with industry and R & D organizations for Collaborative learning
- Enabling and encouraging students for continuing Education and moulding them for life-long learning process

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

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

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

PROGRAMME OUTCOMES (POs)

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

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

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

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

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

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

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

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

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

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

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

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

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

Scheme of 5th Semester

	Bachelor of Engineering(V–Semester)										
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs/Week**				**Credits**	**Examination Marks**		
				L	**T***	**P**	**PJ**		**CIE**	**SEE**	**Total**
1	P21EE501	Management and Entrepreneurship	E&EE	3	-	-	-	3	50	50	100
2	P21EE502	Power System analysis and Stability	E&EE	3	-	-	-	3	50	50	100
3	P21EE503X	**Professional Elective Course-I**	E&EE	3	-	-	-	3	50	50	100
4	P21EE504	Power Electronics (Integrated)	E&EE	3	-	2	-	4	50	50	100
5	P21EE505X	**Open Elective–I**	E&EE	3	-	-	-	3	50	50	100
6	P21EEL506	Circuit Simulation & Auto CAD Laboratory	E&EE	-	-	2	-	1	50	50	100
7	P21INT507	Internship–II	E&EE	-	-	-	-	2	50	50	100
8	P21HSMC508	Employability Enhancement Skills–V	HSMC	1	-	-	-	1	50	50	100
9.	P21UHV509	Social Connect and Responsibility	E&EE	1	-	-	-	1	50	50	100
	Total							**21**			

Professional Elective Course – I (P21EE503X)	
Course Code	**Course Code**
P21EE5031	Utilization of Electrical Power
P21EE5032	Measurement & Instrumentation
P21EE5033	Special Electrical Machines
P21EE5034	Data communication and Networking

Open Elective – I(P21EEO505X)	
Course Code	**Course Code**
P21EEO5051	Power Plant Engineering
P21EEO5052	Renewable Energy Sources
P21EEO5053	Fuzzy Logic
P21EEO5054	Illumination Engineering

	Bachelor of Engineering(VI–Semester)										
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs/Week**				**Credits**	**Examination Marks**		
				L	**T***	**P**	**Pr**		**CIE**	**SEE**	**Total**
1	P21EE601	Computer Techniques in Power Systems	E&EE	3	-	-	-	3	50	50	100
2	P21EE602X	**Professional Elective Course – II**	E&EE	3	-	-	-	3	50	50	100
3	P21EE603X	**Professional Elective Course – III**	E&EE	3	-	-	-	3	50	50	100
4	P21EE604	Control System (Integrated)	E&EE	3	-	2	-	4	50	50	100
5	P21EEO605X	**Open Elective–II**	E&EE	3	-	-	-	3	50	50	100
6	P21EEL606	Power System Simulation Lab	E&EE	-	-	2	-	1	50	50	100
7	P21EEMP607	Mini–Project	E&EE	-	-	2	2	2	50	50	100
8	P21HSMC608	Employability Enhancement Skills–VI	HSMC	1	-	-	-	1	50	50	100
9.	P21UHV609	Universal Human Values and Professional Ethics	E&EE	1	-	-	-	1	50	50	100
	Total							**21**			

Professional Elective Course – I (P21EE602X)	
Course Code	**Course Code**
P21EE6021	PLC and SCADA
P21EE6022	Embedded system & IOT
P21EE6023	Electrical Machine Design
P21EE6024	Power Quality

Professional Elective Course – I (P21EE603X)	
Course Code	**Course Code**
P21EE6031	Switchgear and Protection
P21EE6032	Renewable Energy Sources
P21EE6033	DSP Prosessor and Applications
P21EE6034	Flexible AC Transmission Systems

Open Elective – I(P21EEO605X)	
Course Code	**Course Code**
P21EEO6051	Utilization of Electrical Power
P21EEO6052	Electrical Vehicles
P21EEO6053	Energy auditing and DSM
P21EEO6054	Testing & Commissioning of Electrical Equipment

MANAGEMENT AND ENTREPRENEURSHIP SEMESTER – V			
Course Code:	**P21EE501**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- The course helps students to apply skills pertinent to the management and entrepreneurial management of both existing and emerging technologies.
- Understand engineering safety, strategies, and life cycle properties of a project.
- Be able to plan, organize staff and schedule in both small and large organizations with an engineering context.

UNIT – I	**Introduction**	**8 Hours**

MANAGEMENT: Introduction Meaning nature and characteristics of Management, Scop 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.

Self-study component:	Motivation theory, wages and incentives.

1. **Source material to be referred**: Textbook 1- Chapter 1, Chapter 2, Chapter 4.
2. **Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – II	**Functions of Management**	**8 Hours**

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.

Self-study component:	Structures of HR department.,

1. **Source material to be referred**: Textbook 1- Chapter 7, Chapter 8, Chapter 9, Chapter 11, Chapter 15, Chapter 16, Chapter 17.
2. **Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – III	**Entrepreneurship and SSI**	**8 Hours**

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.

Small Scale Industry: Definition; Characteristics, Objectives, Scope, role of SSI in Economic Development. Impact of Liberalization, Privatization, Globalization on SSI. Effect of WTO / GATT, Supporting Agencies of Government for SSI-Meaning.

Self-study component:	Basics of Digital Marketing

1. **Source material to be referred**: Textbook 2 – 1.1 to 1.11,
2. **Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – IV	**Project Management**	**8 Hours**

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.

Self-study component:	Study of Project management in industry.

1. **Source material to be referred**: Textbook 2: 15.2 to 15.7, 16.1 to 16.2
2. **Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – V	**Professional Ethics**	**8 Hours**

Engineering and Professional Ethics: Introduction, Role Morality, What is a Profession?, Professional Ethics, The NSPE Board of Ethical Review, Engineering Ethics as Preventive Ethics
Honesty: Introduction, Ways of Misusing Truth, Why is Dishonesty Wrong?
International Engineering Professionalism: Introduction, Problems in International Professionalism, Problems in Interpreting and Applying the Codes, Guidelines for Interpreting the Codes: Human Rights, Avoiding Paternalism and Exploitation and Applying the Golden Rule.

Self-study component:	Survey and Study the importance of Professional Ethics

1**. Source material to be referred**: Textbook 3: 1.1 to 1.6, 6.1 to 6.3 & 10.1 to 10.8
2**. Learning Validation method:** Group Activities
3**. Pedagogy method used:** Chalk and talk, Power point presentation, case study.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the theory of management, ethics and entrepreneurship	Apply	L3
CO2	Foster analytical and critical thinking abilities for data based decision making.	Analyze	L4
CO3	Ability to develop value based leadership.	Analyze	L4

CO4	Ability to understand, analyze and communicate global, economic, legal and ethical aspects.	Analyze	L4

Text Book(s):

1. "Principles of Management", P C Tripati, PN Reddy, Tata McGraw Hill, 4th edition, 2008, ISBN (13) : 978-0-07-022088 and ISBN (10) : 0-07-022088-3.
2. "Entrepreneurial Development", by Dr S S Khanka, S Chand & Company Ltd.2008, ISBN-10: 8121918014; ISBN-13: 978-8121918015.
3. "Engineering Ethics" (2nd edition), Charles E. Harris, Michel S. Pritchard and Michel J. Rabins, Thomson Wadsworth Asia Pte Ltd, 2003. ISBN: 981-243-676-6.

Reference Book(s):

1. Chandan M, Jagadish V K, Nandan V H, "Basic Management Skill and Energy Management", ISBN: 979-888849235-2
2. 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		**Program Outcomes**													
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2
1	Apply the theory of management, ethics and entrepreneurship	3	-	-	-	-	-	-	2	2	2	-	2	-	-
2	Foster analytical and critical thinking abilities for data based decision making.	-	3	-	-	-	-	-	-	2	2	-	2	-	-
3	Ability to develop value based leadership.	-	3	-	-	-	-	-	-	2	2	2	2	-	-
4	Ability to understand, analyze and communicate global, economic, legal and ethical aspects.	-	3	-	-	-	-	-	2	2	2	-	2	-	-
1-Low		**2-Medium**											**3-High**		

Review Questions

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.
6. Discuss Nature and purpose of organization, principles of organization Types of organization
7. Define Committees Centralization V/s Decentralization of authority and responsibility Span of control
8. Explain Nature and importance of Staffing Process of Selection &Recruitment
9. Discuss Meaning and nature of directing Leadership styles, Motivation Theories, Communication Meaning and importance
10. Discuss and Explain Meaning and steps in controlling Essentials of a sound control system Methods of establishing control
11. Explain Meaning of Entrepreneur, Evolution of Concept, Functions of Entrepreneur, Types of Entrepreneur
12. Discuss Evolution of Entrepreneurship, Development of Entrepreneurship
13. Explain Stages in entrepreneurial process, Role of Entrepreneurs in Economic development
14. Discuss entrepreneurship in India, entrepreneurship – its barriers
15. Define Characteristics; Need and rationale: Objectives, Scope, and role of SSI in Economic Development. Advantages of SSI
16. Explain Steps to start an SSI Government policy towards SSI, Different Policies of SSI, Government Support on SSI during 5 year plans
17. Discuss Impact of Liberalization, Privatization and Globalization on SSI. Effect of WTO / GATT Supporting Agencies of Government
18. Define and Explain Functions; Types of Help; Ancillary Industry and Tiny Industry
19. Discuss Meaning of Project, Project Identification, Project Selection, Project Report, Need and significance of Report, Contents, formulation
20. Define and Explain Guidelines by Planning Commission for Project Report, Network Analysis Errors of Project Report, Project Appraisal
21. Discuss Identification of Business Opportunities
22. Explain Market Feasibility Study: Technical Feasibility Study, Financial Feasibility Study & Social Feasibility study.
23. Explain the role of morality and Professional Ethics.
24. Explain the ways of misuing truth and discuss Dishonesty Wrong with an

example.

25. Explain the NSPE board Ethical Review in detail
26. Explain the problems in international professionalism.
27. Explain Problems in Interpreting and Applying the Codes
28. Explain the guidelines for Interpreting the Codes.
29. Explain how to avoid Paternalism.
30. Mention the golden rules for Exploitation

POWER SYSTEM ANALYSIS & STABILITY SEMESTER – V			
Course Code:	**P21EE502**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

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

UNIT – I	**Representation of Power System Components**:	**08 Hours**

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 component:	Per unit system- merits and demerits

UNIT – II	**Symmetrical Fault Analysis**:	**08 Hours**

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 component:	Selection of circuit breakers

UNIT – III	**Symmetrical Components:**	**08 Hours**

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 component:	Sequence network of power system

UNIT – IV	**Unsymmetrical Faults:**	**08 Hours**

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.

Self-study component:	Open conductor faults in power systems

UNIT – V	**Stability Studies:**	**08 Hours**

Steady state and transient stability, Steady state and transient stability limits. Power angle equation, Rotor dynamics and Swing equation. Illustrative examples.

Self-study component:	Equal area Criterion for stability.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply circuit models and per unit diagram to represent power system components	Apply	L3
CO2	Analyze of symmetrical and unsymmetrical faults on power system	Analyze	L4
CO3	Analyze the stability of power system under abnormal conditions	Analyze	L4
CO4	Solve numerical problems on faults and stability using software	Apply	L3

Text Book(s):

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(s):

1. K. Neelakantan, "Power system Analysis and Stability"Revised edition
2. Hadi Sadat, "Power system analysis", TMH,2nd Edition, 2010

Web and Video link(s):

- Quantum Mechanics: https://youtu.be/xlrvgLUsKqU
- Lasers: https://youtu.be/Ab1nxxkgjH8
- Fiber optics: https://youtu.be/9seDKvbaoHU

E-Books/Resources:

- http://de.physnet.net/PhysNet/education.html
- http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

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 and per unit diagram to represent power system components	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	Analyze of symmetrical and unsymmetrical faults on power system		3	-	-	-	-	-	-	-	-	-	-	2	-
3	Analyze the stability of power system under abnormal conditions		3	-	-	-	-	-	-	-	-	-	-	2	-
4	Solve numerical problems on faults and stability using software		3	-	-	3	-	-	-	-	-	-	-	2	-
1-Low		2-Medium								3-High					

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

Utilization of Electrical Power **SEMESTER – V**			
Course Code:	**P21EE5031**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the different types of heating and welding.
- Understand the different Lighting scheme and types of lamps.
- To study about Electric traction.
- To get the knowledge of speed-time characteristics of Electric train.
- To study the different traction motors and their applications

UNIT – I	**Electric Heating and Welding**	**08 Hours**

Introduction, mode of heat transfer, advantages and methods of electric heating, resistance heating, arc heating, induction heating, Dielectric heating, Electric welding and their types.

Self-study component:	

1. **Source material to be referred**: 1 indicated Textbook 1, Chapter 2, Concept 2.1 to 2.2
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – II	**Illumination**	**08Hours**

Introduction, Definitions, Laws of illumination, Lighting schemes, Design of lighting scheme, construction and working of Incandescent, sodium vapour lamp, mercury vapour lamp, fluorescent lamp, CFL and LED light bulb.

Self-study component:	street lighting, factory lighting, Flood lighting

1. **Source material to be referred**:1 indicated Textbook 1, Chapter 1,Concept 1.1,1.2,1.3,1.7,1.9,1.10
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – III	**Systems of Electric Traction**	**08 Hours**

Introduction, requirement of an ideal traction system, System of traction, various types of electric traction, electric trains, tramways, trolley buses, systems of electrification for traction purposes, Methods of supplying power to Railway trains, Applications of systems for Railway electrifications.

Self-study component:	Diesel electric traction

1. **Source material to be referred**: 2 indicated Textbook 2, Chapter 46, Concept 1 to 9.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – IV	**Speed-Time Characteristics**	**08 Hours**

Analysis of speed-time curve for electric train, Important Terms used in traction, Simplified Speed-Time curves, tractive effort for propulsion of train, specific energy output, various factors affecting energy consumption.

Self-study component:	Types of railway systems

1. **Source material to be referred**:1 indicated Textbook 1,Chapter7,Concept 7.1,7.2,7.3,7.4,7.6,7.7,7.8.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – V	**Traction Motors**	**08 Hours**

Introduction, selection of traction motors, DC Motor, AC series motor, Three Phase Induction Motor, Methods of speed control - energy saving by series-parallel method, electric braking- plugging, rheostatic braking, regenerative breaking.

Self-study component:	linear induction motor and their use

1. **Source material to be referred**: 1 indicated Reference Book 1, Chapter 4, Concept 4.9, 4.10, 4.13.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic physics to study the utilization of electrical power.	Understand	L2
CO2	Analyze the different electric traction system.	analyze	L4
CO3	Solve numerical problems on electrical power utilization	analyze	L4
CO4	Evaluate effective lighting schemes for various applications	evaluate	L5

Text Book(s):

1. Er.R. K Rajput "UTILIZATION OF ELECTRICAL POWER" ,Laxmi publication (P) Ltd, 2nd edition 2018.
2. Dr. S.L. Uppal, Prof. S Rao "ELECTRICAL POWER SYSTEMS", Khanna Publishers,15th edition, 2011

3. A.Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, "Power system Engineering", Dhanpat Rai& Co., 2010.

Reference Book(s):

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

Web and Video link(s):

- https://www.youtube.com/watch?v=jn9ouzQl37k
- https://www.youtube.com/watch?v=VqDIh356104
- https://www.youtube.com/watch?v=zMaO8rcEhdI
- https://www.youtube.com/watch?v=PW44aMos2YA
- https://www.youtube.com/watch?v=ekOBzHGV9XE
- https://www.youtube.com/watch?v=ingbs2FzsTA

E-Books/Resources:

- https://easyengineering.net/utilisation-of-electrical-power-by-rajput/
- https://www.bookslock.org/utilization-of-electrical-energy-textbook-pdf-eee-books/
- https://book.jobscaptain.com/utilisation-of-electrical-power/

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 physics to study the utilization of electrical power.	3											1		
2	Analyze the different electric traction system.		3										1		
3	Solve numerical problems on electrical power utilization		3												
4	Evaluate effective lighting schemes for various applications			3											

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

Assignment Questions

1. What are the advantages of electrically produced heat? Describe the constructional features of a resistance oven. What properties the element must possess?

2. A 40-kW, 3-phase, 400-volt resistance oven is to employ Ni-Cr strip of 0.3 mm thickness. The heating elements are star connected. If the wire temperature is to be 1127°C and that of charge is to be 727°C, estimate the suitable width and length of the wire required. Radiation efficiency = 0.6, specific resistance of Ni-Cr = 1.03x 10 ohm-m. Emissivity =0.9. What would be the temperature of the wire when the charge is cold?
3. Distinguish between the direct and indirect type of arc furnaces. State their field of application.
4. Estimate the rating of an induction furnace to melt two tonnes of zinc in one hour if it operates at an efficiency of 70%. Specific heat of zinc is equal to 0.1, Latent heat of fusion of zinc 26.67 k-cal per kg. Melting point is 455°C. Assume the initial temperature to be 25°C.
5. Describe the construction and working of an induction furnace suitable for melting and refining of non-ferrous metals.
6. A 50-kW, 3-phase, 400-V resistance oven is star-connected. Heating element used is nickel-chrome strip 0.25 mm thick. If the wire temperature is to be 1,000°C and that of the charge is to be 727°C, estimate a suitable width and length of the wire required. Take emissivity = 0.9, radiating efficiency = 0.6, specific resistance of nickel-chrome = 1.03 ×10b ohm-m.
7. Discuss the principle of arc welding and the difference between carbon and metallic arc welding and their relative merits.
8. An indoor badminton court is accommodated in a hall 20 metres long, 10 metres wide and 15 metres high. The walls and ceiling of the hail are painted black and do not reflect, any light. Design a scheme for providing an average illumination of 80 lux at ground surface, using 200 W tungsten filament lamps with suitable fittings. Give reasons for your choice. Coefficient of utilization = 0.5.Efficiency of lamp = 15 lumens per watt.
9. With the help of circuit diagrams, explain the working of the following light sources :
   (i) High pressure mercury vapour lamps (b) Fluorescent tube (c) Carbon arc lamp .What are the usual values of power factors for the above lamps?
10. Give a detailed account of fluorescent lamps of various types. How is the stroboscopic effect minimized? What are their advantages and disadvantages as compared to other light sources?
11. What are the polar curves as applied to light sources? Show how these curves are used for finding out mean horizontal candle power and mean spherical candle power.
12. Explain the the terms: (i) Adhesive weight, and (ii) Train resistance.
13. A locomotive accelerates a 400-tonne train up a gradient of 1 in 100 at 0.8 km phps. Assuming the coefficient of adhesion to be 0.25, determine the minimum adhesive weight of the locomotive. Assume train resistance of 60 N per tonne and allow 10% for the effect of rotational inertia.
14. An electric train while going down an incline of 1 in 200 has the following speed-time curve : (i) Starting from rest a uniform acceleration of 2 km phps for 30 sec. (ii) Steady speed for 40 seconds (with mechanical braking), (ii) Coasting for 50 seconds and (iv)

Braking at rate of 3 km phps. Assume the track resistance as 45 N per tonne, allowance for rotational inertia 10%, overall effi ciency 70%, and calculate the specific energy consumption.

15. What are the typical values of acceleration and braking retardation in electric traction ? How is the value of acceleration or retardation calculated from the data of a typical speed-time curve ?
16. Deduce expressions for:
    (i) the tractive effort exerted by the road wheel in terms of wheel diameter, motor torque gear ratio and the efficiency of transmission of power through gears;
    (ii) The tractive effort for propulsion of a train on level track;
    (iii) The tractive effort for propulsion of a train up and down a gradient;

Review questions

1. What are the advantages of electric heating?
2. Give classification of various electric heating methods along with brief account of their working principle.
3. Explain briefly the following modes of heat transfer : conduction, Convection, Radiation.
4. List the properties of a good heating element.
5. Explain briefly the materials of heating elements.
6. Discuss the methods of temperature control of resistance ovens.
7. Explain the design procedure of the heating elements when the power and voltage of the oven is known.
8. Explain the working principle of arc furnaces and describe with the help of a sketch the construction and working of any one type of arc furnace.
9. Describe the construction and working of a 3-phase arc furnace.
10. Describe the conditions for maximum output for an electric arc furnace.
11. Mention the advantages of dielectric heating.
12. Discuss the relative merits and demerits of direct and indirect electric arc furnaces.
13. Explain different methods of induction heating. Give some applications of induction heating.
14. What is the basic nature of light ? Explain.
15. Define the following terms :
16. Luminous flux, Lumen, Illumination, Lamp efficiency & Explain briefly the following:Space-height ratio, Utilization factor, Depreciation factor.
17. What is a solid angle?
18. State the laws of illumination.
19. Enumerate the various types of electric lamps in common use.
20. Explain briefly the materials commonly used for incandescent lamps.
21. Explain with a neat sketch, the construction and working of a sodium vapour lamp.
22. Give the construction and working of a 'fluorescent tube'.
23. Explain briefly the various types of lighting systems.

24. Enumerate the characteristics which the lighting scheme should possess.
25. Revive expressions for illumination on a surface (i) when it is normal and (it) when it is inclined to the axis of a beam of incident light.
26. What is a polar curve? How is it useful to an illumination engineer?
27. What do you understand by polar curves? Explain Rousseau's construction for calculating m.s.c.p. of a lamp.
28. Why is tungsten selected as the filament material and on what factors does its life depend ?
29. Prove that in a filament lamp the diameter of filament is directly proportional to r, where I is the current flowing in the filament.
30. Explain the advantages of using inert gas in filament lamps and the purpose to get the filament as coiled coil.
31. Describe the metal filament lamps high lighting the effect of temperature and the choice of filament materials.
32. Explain the effects of voltage variation on the life and illumination as regards tungsten lamp and fluorescent lamp.
33. Compare the metal filament lamp with discharge lamp.
34. Compare the metal filament lamp with discharge lamp. What is the advantage of coiled coil? Describe principle of operation, construction and working of a sodium discharge lamp.
35. State the significant fentures of traction drives.
36. Discuss briefly the desirable properties of traction motors.
37. What are the chief requirements of a traction motor with regards to electrical and mechanical features ?
38. Give the essential electrical and mechanical characteristics of traction motora.
39. State the mechanical and electrical features of electric traction motors and discuss the relative suitability of (i) D.C. series motor, (li) A.C. series motor.
40. Enumerate the motors which commonly find application in traction.
41. State the advantages of squirrel-cage induction motor over D.C. motors.
42. What is the major disadvantage of a D.C. motor?
43. Discuss the suitability of series motors for traction duties with the help of characteristic curves.
44. Discuss in detail why series motors are ideal for D.C. or A.C. traction.
45. What is the effect of changing wheel diameter and gear ratio on the characteristics of a motor?
46. State the effects of wheels that are worn out when used along with new wheels to drive a train.
47. What speed-torque characteristics are desirable for traction motors operating (i) suburban services (it) main line service?
48. Explain how the difference in driving wheel diameters due to unequal wear affects the sharing of load by two similar series motors, working in parallel, driving an electric train.

49. What type of A.C. motor is usually employed for single-phase electric traction? Discuss briefly the principal features in the construction of the motor and analytically how good commutation and high power factor are obtained. For what frequency and voltage are such motors usually built and why?
50. Explain briefly the construction and characteristics of A.C. series motor, pointing out how they differ from the D.C. type. In what way is the good commutation and high power factor assured ?
51. Discuss with neat sketches the construction and working principle of high acceleration linear induction motor. Discuss its advantages and disadvantages.
52. State the merits and demerits of the induction motor for traction duties.
53. Discuss the advantages of series-parallel starting against the ordinary rheostatic starting for a pair of D.C. traction motors.

Measurement & Instrumentation SEMESTER – V			
Course Code:	**P21EE5032**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the construction & working of different Electrical &Electronic instruments.
- Study the principle of operation & working of different measurement bridges
- Explore types of instrument ranges with statistical examples
- Create awareness on different Electrical transducers used in engineering

UNIT – I	**Introduction to basic measuring concepts**	**10 Hours**

Essential torques, Basic types of instruments, operating principle of Ammeters, voltmeters, wattmeter (LPF & UPF), Energy meter–errors& adjustments, illustrative examples. Construction and operation of single-phase and three-phase dynamometer type power factor meter.

Self-study component:	**Weston Frequency Meter**

1. **Source material to be referred**: Textbook 1- Pg. No. 237-9.1,9.2,9.9,9.10; Pg. No. 351-11.1,11.2; P g. No. 382-12.7 – 12.7.10; Pg. No. 405-13.1.1-13.1.2
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board & group discussion.

UNIT – II	**DC & AC Bridges for Measurement of R,L,C**	**10 Hours**

Wheatstone bridge - sensitivity analysis & limitations, Kelvin's double bridge, Cable and Earth resistance measurement using Megger, Illustrative examples.
Anderson's bridge, Schering bridge, Sources and detectors, Shielding of bridges, Illustrative Examples.

Self-study component:	**Wagner Earthing device**

1**. Source material to be referred**: Textbook 1- Pg. No. 485-16.5.4; Pg. No. 489-16.6.2; Pg. No. 925-26.22.1-26.22.3; Pg. No. 436-14.3.3-14.3.3A; Pg. No.256-9.8
2**. Learning Validation method:** Unit test
3**. Pedagogy method used:** chalk and talk, Power point presentation, smart board & group discussion.

UNIT – III	**Extension of instrument ranges**	**10 Hours**

a) Shunts and Multipliers, Illustrative examples.
b) Instrument Transformers - Construction and theory, Equations for ratio and phase angle errors of C.T. and P.T (P.T derivations excluded), Turns compensation, Illustrative examples (excluding problems on turns compensation)

Self-study component:	**Clamp on meter**

1. **Source material to be referred**: Textbook 1- Pg. No. 241-9.4.3; Pg. No. 260-9.9.5;Pg. No. 315-1 0.5.6,10.5.2; Pg. No. 330-10.6.1,10.6.3,10.6.5;
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board & group discussion.

UNIT – IV	**Electronic Instruments & Transducers**	**10 Hours**

Introduction, True RMS responding voltmeter, Digital Multimeter, Digital voltmeters, Digital Tachometer, Electronic Energy meters

Classification and selection of transducers, Strain gauges, LVDT, Temperature measurements.

Self-study component:	**Transducers in Electronic circuits**

1. **Source material to be referred**: Textbook 1- Pg. No. 619-20.10; Pg. No. 620-20.11;Pg. No. 1029-28.31; Pg. No. 1083-29.22.1; Pg. No. 755-25.6-25.9; Pg. No. 776-25.16-25.17(only types); Pg. No. 805-25.24; Pg. No. 793-25.2.1
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, & group discussion.

UNIT – V	**Oscilloscopes and Display Devices**	**10 Hours**

Front panel details of a typical dual trace oscilloscope, Method of measuring amplitude, Phase, Frequency, Period, Use of Lissajous patterns, Working of a digital storage oscilloscope, X-Y recorders, LED display.

Self-study component:	**LCD Display**

1. **Source material to be referred**: Textbook 1-Pg. No. 658-664-21.17-21.21.1; Pg. No. 672-21.24.1; Pg. No. 672-21.24.1; Pg. No. 1039-28.47; Pg. No. 1012-28.10;
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board & group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the basic techniques to measure electrical parameters of measuring instruments	L3	Apply
CO2	Analyze the construction and working principle of various electrical and electronics measuring instruments.	L4	Analyze
CO3	Solve numerical problems on measuring electrical quantities	L4	Analyze
CO4	Conduct a study on various measuring instruments	L3	Apply

Text Book(s):

1. A.K.Sawhney, "**Electrical and Electronic Measurements and Instrumentation"**, DhanpatRai & Sons, 19th Revised Edition, 2019
2. David A Bell, "**Electronic Instrumentation and Measurements"**, PHI, 2nd Edition, 2012.

Reference Book(s):

1. Golding and Widdies, "**Electrical Measurements and Measuring Instruments"**, Pitman, 5thEdition.
2. Harris, "**Electrical Measurements"**, John Wiley, 2ndEdition.,1995.

Course Outcome (CO)	Program Outcome													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Apply the basic techniques to measure electrical parameters of measuring instruments	**3**											2	**2**	
Analyze the construction and working principle of various electrical and electronics measuring instruments.		**3**											2	
Solve numerical problems on measuring electrical quantities		**3**											2	
Conduct a study on various measuring instruments	**2**	**2**				**1**			**2**	**2**		**2**	**2**	

Assignment Questions

List the unit wise assignment questions,

- Mention at least three differences in construction of ammeter, voltmeter and power factor meter
- Explain basic concepts of controlling torque and damping torques.
- What are the basic types of measuring instruments.
- Describe the differences among power factor meter and wattmeter
- Draw the phasor diagram of single phase and three phase PF meter
- List out the differences between wheat stone and kelvin's double bridge
- With neat circuit and phasor diagram, explain Schering bridge
- With neat sketches explain the constructional details PT & CT
- Explanation about construction and operation of shunts and multipliers
- With neat sketch and relate equations explain the operation of Electronic Energy meter
- With block diagram, explain the operation of digital storage oscilloscope

Mandatory assignment:

1. Group of students have to submit a report on dismantled voltmeter / ammeter / wattmeter / PF meter / energy meter / tachometer / with specifying their parts, type, functioning and application

Review questions

1. Explain the construction and working of single phase dynamometer type power factor meter.
2. Explain the construction and working of Three phase dynamometer type power factor meter.
3. Explain the advantages of Electronic voltmeters over conventional type voltmeters.
4. Explain the constructional features of electronic multimeter.
5. Describe the working principle of digital voltmeter.
6. Explain the Kelvin's double bridge for the measurement of low value of resistance.
7. Describe the working of Anderson's bridge with neat phasor diagram
8. Discuss the significance of sources and detectors.
9. Describe the sensitive analysis and limitations of Wheatstone bridge.
10. Explain the construction and working of single phase energy meter
11. Why Kelvin bridge is preferred? Derive the equation for Kelvin double bridge.
12. With neat circuit explain the operation of True RMS responding voltmeter,
13. Discuss the special features of low power factor wattmeter.
14. Define strain gauges and gauge factor.
15. Explain the classification and selection of transducers.
16. Explain the errors and adjustments for the energy meter.
17. Describe the construction and theory of shunts and multipliers.
18. Illustrative examples on the shunts and multipliers.
19. Define the ratio error and phase angle errors of C.T. and P.T
20. Illustrative examples on the turn's compensation.
21. With neat circuit explain the operation of Digital Multimeter
22. With neat circuit explain the operation of Digital voltmeters,
23. Explain the front panel details of a typical dual trace oscilloscope
24. With neat circuit explain the operation of Digital Tachometer
25. With neat circuit explain the operation of Electronic Energy meters
26. Describe the overview of applications of CRO.
27. With neat circuit explain the operation of LED
28. Explain the methods of measuring amplitude, phase, frequency, and period.
29. Analyze the use of Lissajous patterns.
30. With neat sketch explain x-y recorders.
31. Explain the working of a digital storage oscilloscope
32. Explain the working of earth resistance measurement using megger
33. Explain the constructional details of megger
34. Description of Schering bridge for the measurement of capacitance.
35. With neat sketches explain the constructional details PT & CT
36. With neat circuit explain the operation of LED

Special Electrical Machines SEMESTER – V			
Course Code:	**P21EE5033**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to understand:

- An overview of some of the special machines for control and industrial applications.
- Constructional & operational aspects of various Special Electrical Machines.
- Properties and characteristics of various Special Electrical Machines.
- Evaluate performance of various Special Electrical Machines
- Select appropriate machine based on application requirements

UNIT – I	**Stepper Motors**	**8 Hours**

Constructional features, principle of operation, types, modes of excitation, Torque production in Variable Reluctance (VR) stepping motor, Static and Dynamic characteristics, Introduction to Drive circuits for stepper motor, suppressor circuits, Applications.

Self-study component:	Closed loop control of stepper motor

1**. Source material to be referred**: 2.21.12, 3.38.2-3.38.8
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** Chalk and talk, Power point presentation, Smart board.

UNIT – II	**Switched Reluctance Motors**	**8 Hours**

Principle of Operation, Constructional features, Torque equation, Power Semi Conductor Switching Circuits, frequency of variation of inductance of each phase winding - Control circuits of SRM- Torque - Speed Characteristics, Applications.

Self-study component:	Microprocessor based control of SRM Drive

1. **Source material to be referred**: 2.21.14, 3.38.19
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** Chalk and talk, Power point presentation, Smart board.

UNIT – III	**Permanent Magnet Brushless DC Motors**	**8 Hours**

Commutation in DC motors, Electronic Commutation- Hall sensors, Optical sensors, Construction and principle of PMBL DC Motor, Torque and E.M.F equation, Torque-speed characteristics, Power Controllers-Drive Circuits, Applications.

Self-study component:	Difference between mechanical and electronic commutators

1. **Source material to be referred**:2.21.15, 3.38.9-3.38.12
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** Chalk and talk, Power point presentation, Smart board.

UNIT – IV	**Permanent Magnet Synchronous Motors**	**8 Hours**

Construction and types, Principle of operation, EMF and Torque equation, Phasor diagram- Torque Speed Characteristics, Power controllers- Self control, Microprocessor Based Control, Applications.

Self-study component:	Vector control

1. **Source material to be referred**:3.38.13-3.38.18

2. **Learning Validation method:** Compulsory Unit test

3. **Pedagogy method used:** Chalk and talk, Power point presentation, Smart board.

UNIT – V	**Other Special Electrical Machines**	**8 Hours**

Constructional features Principle of operation and Characteristics of Hysteresis motor- Synchronous Reluctance Motor–Linear Induction motor- Applications.

Self-study component:	Repulsion motor

1. **Source material to be referred**: 3.38.19, 4.9.2, 4.9.3, 4.9.10

2. **Learning Validation method:** Compulsory Unit test

3. **Pedagogy method used:** Chalk and talk, Power point presentation, Smart board.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Illustrate the construction and operation of various Special Electrical Machines.	Understanding	L2
CO2	Apply the knowledge of basic electrical laws to derive EMF equation & Torque equation of various special Electrical Machines.	Applying	L3
CO3	Analyze Torque - Speed Characteristics of various special Electrical Machines.	Analyzing	L4
CO4	Develop control circuits for various special Electrical Machines.	Applying	L3

Text Book(s):

1. Venkatratnam K., Special Electric Machines, CRC Press.
2. "Theory & performance of Electrical Machines"- J. B. Gupta, Published by S K Kataria & Sons, 15th edition- 2017
3. B.L Theraja "Electrical Technology" Volume2, S. Chand, 22nd Edition.
4. Ashfaq Hussain, "Electrical Machines", Dhanapat rai and Co, 2nd edition, 2012

Reference Book(s):

1. Alexander Langsdorf, "Theory of Alternating Current Machines", T.M.H, 2001
2. M.G. Say, "Performance and Design of A.C. Machines", C.B.S. Publishers, 2005
3. Miller T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press.
4. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press.

Web and Video link(s):

https://archive.nptel.ac.in/courses/108/102/108102156/

E-Books/Resources:

https://www.studocu.com/in/document/dr-apj-abdul-kalam-technical-university/btech/special-electrical-machines-kee061ee/53004672

Course Outcome (CO)	Program Outcome													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
Apply the knowledge of basic electrical laws to study the construction and operation of various Special Electrical Machines.	3											2	2	
Analyze the performance characteristics of special Electrical Machines.		3											3	
Examine the control circuits for various special Electrical Machines.		3											3	
Solve the numerical problems on various Special Electrical Machines.		3											2	

Assignment Questions

1. List the unit wise assignment questions,
   - Ask at least three HOTS (Higher order Thinking) questions, which promotes critical thinking
   - Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

Review questions

1. What is stepper motor?
2. Define step angle.
3. Define slewing
4. Define resolution
5. Mention some applications of stepper motor
6. What are the advantages and disadvantages of stepper motor?
7. Define holding torque.
8. Define detent torque
9. Define pull in torque.
10. Define pull out torque.
11. Give the types of driver circuits.
12. What is multi stack VR motor
13. What is meant by micro stepping in stepper motor?
14. What is SRM?

15. What are the advantages of SRM?
16. What are the disadvantages of SRM?
17. Why rotor position sensor is essential for the operation of switched reluctance motor?
18. What is the different power controllers used for the control of SRM?
19. What are the applications of SRM?
20. What are the two types of current control techniques?
21. Write the torque equation of SRM?
22. What is phase winding?
23. Write the characteristics of SRM.
24. Define the control system of SRM.
25. What are the major advantages of frequency control of SRM?
26. Define the isolation of SRM.
27. Define the power circuitry of SRM.
28. What are the current control schemes?
29. What are the advantages of brushless dc motors drives?
30. What are the disadvantages of brushless dc motors drives?
31. Define mechanical commutators?
32. Define electronic commutators?
33. Mention some applications of PMBL DC motor?
34. What are conventional DC motors?
35. What are PMBL DC motors?
36. Why the PMBLDC motor is called electronically commutated motor?
37. What are the classifications of BLPM DC motor?
38. What are the two types of rotor position sensors?
39. What are applications of stator?
40. What are the classifications of BLPM dc motor?
41. What are merits of 3phase BLPM synchronous motor?
42. What are the demerits of 3 phase BLMP synchronous motor?
43. What are the rotor configurations?
44. What are the advantages of load commutation?
45. What are advantages of synchronous motor?
46. What are the applications of synchronous drive?
47. What are the features of permanent magnet synchronous motor?
48. What are the applications of PMSM?
49. What are assumptions made in derivation of EMF equation for PMSM?
50. What is meant by synchronous reactance?

Data communications and Networking SEMESTER – V			
Course Code:	**P21EE5034**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives:

This course will enable the students to understand :

The basic concepts of **data communication**, layered model, protocols, various types of **transmission** media, **network** devices, and to learn the techniques in error detection and correction.

UNIT – I	**Introduction to Data communications& Networking**	**08 Hours**

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 component:	Transmission impairment

1. **Source material to be referred**: Text Book 1
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study

UNIT – II	**Data, signals and digital transmission:**	**08 Hours**

Analog and digital, periodic analog signals, digital signals, transmission impairment, data rate limits, performance, analog-to-digital conversion, transmission modes.

Self-study component:	digital-to-digital conversion

Source material to be referred: Textbook 1.

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, Power point presentation, case study

UNIT – III	**Transmission media:**	**08 Hours**

Guided media, unguided media: wireless, circuit-switched networks, datagram networks, virtual circuit networks

Self-study component:	structure of a switch

Source material to be referred: Textbook 1

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities, Programming Simulation study

UNIT – IV	**Error detection and correction**	**08 Hours**

Introduction, block coding, linear block codes, cyclic codes, checksum, framing, flow and error control, protocols, random access, aloha, controlled access.

Self-study component:	noisy and noiseless channels

Source material to be referred: Textbook 1., Chapter 1, Concept 1 in chapter 1.
Learning Validation method: Compulsory Unit test
Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities,

group discussion.		
UNIT – V	**Wired lans& wireless lans**	**08 Hours**
IEEE standards, standard ethernet, changes in the standard, fast ethernet, IEEE 802.11, Bluetooth.		
Self-study component:	gigabit Ethernet	

Source material to be referred: Textbook 1& 2.
Learning Validation method: Compulsory Unit test
Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of Engineering to understands basic overview, terminology of Data Communication and Networking	Apply	L1
CO2	Analyze the Network models, transmission media, error identification, LANS and switching	Analyze	L2
CO3	Solve problems associated with data communication and networking	Analyze	L3
CO4	Carry out a case study to understand various networking topology/switching/transmission media/lans and provide proper documentation	Execute	L4

Text Book(s):

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

Reference Book(s):

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.

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	PS O1	PS O2
1	Apply the knowledge of Engineering to understands basic overview, terminology of Data Communication and Networking	3	-	-	-	-	-	-	2	2	2	-	2	-	-
2	Analyze the Network models, transmission media, error	-	3	-	-	-	-	-	-	2	2	-	2	-	-

	identification, LANS and switching														
3	Solve problems associated with data communication and networking	-	2	3	-	-	-	-	-	2	2	2	2	-	-
4	Carry out a case study to understand various networking topology/switching/transmission media/lans and provide proper documentation	2	3	-	-	1	2	-	-	2	2	-	2	-	-
1-Low						**2-Medium**							**3-High**		

Assignment Questions

1. For each of the following four networks, discuss the consequences if a connection fails.
   a. Five devices arranged in a mesh topology
   b. Five devices arranged in a star topology (not counting the hub)
   c. Five devices arranged in a bus topology
   d. Five devices arranged in a ring topology
2. A color image uses 16 bits to represent a pixel. What is the maximum number of different colors that can be represented?
3. Compare the telephone network and the Internet. What are the similarities? What are the differences?
4. Suppose a computer sends a frame to another computer on a bus topology LAN. The physical destination address ofthe frame is corrupted during the transmission. What happens to the frame? How can the sender be informed about the situation?
5. Suppose a computer sends a packet at the network layer to another computer somewhere in the Internet. The logical destination address of the packet is corrupted. What happens to the packet? How can the source computer be informed of the situation?
6. Suppose a computer sends a packet at the transport layer to another computer somewhere in the Internet. There is no process with the destination port address running at the destination computer. What will happen?
7. If the data link layer can detect errors between hops, why do you think we need another checking mechanism at the transport layer?
8. What is the theoretical capacity of a channel in each of the following cases:
9. What is the length of a bit in a channel with a propagation speed of 2 x 108 mls if the channel
   a. Bandwidth: 20 KHz SNRdB =40
   b. Bandwidth: 200 KHz SNRdB =4
   c. Bandwidth: 1 MHz SNRdB =20

10. Discuss about presently available serial and parallel communication channels
11. Discuss about various types of guided and unguided media available in market and their applications
12. List various wireless protocols and their uses

Review questions

Introduction

1. What is meant by Data Communication and explain its characteristics?
2. What are the components of Data communication?
3. Explain different Data flow directions.
4. What is Network and explain characteristics of Networks?
5. Write about different types of connections.
6. Explain different types of topologies.
7. Explain different types of Networks.
8. Write about Protocol and Standards.

Network Models

1. Explain different layers in OSI Model.
2. Explain the layers of TCP/IP model.
3. Write about peer-to-peer processing.

Data and Signals

1. Fundamentals of Data and Signals.
2. Write about Digital Signals.
3. Write about Composite Signals
4. Different methods for Digital signal transmission.
5. Write about Transmission Impairments.
6. Different Criteria for the performance of Networks.

Transmission medium

1. What is transmission medium? What are the different types of transmission medium?
2. Write about Guided medium.
3. Write about Un-guided medium.

Switching

1. What is Switching and What are the different types of Switching Techniques?
2. Write about Circuit Switched Network.
3. Write about Datagram Network.
4. Write about Virtual Circuit Network.

Error Detection and Correction

1. Explain different types of errors in data transmission.
2. Write about Redundancy, Detection versus Correction, Forward Error

Correction versus Retransmission and Coding
3. Write about Block Coding and explain how the errors are detected and corrected using Block coding?
4. What is Hamming distance and write about minimum Hamming distance?
5. What is meant by linear Block Code and explain Simple Parity-Check Code?
6. Write about Hamming codes.
7. What is cyclic code and explain Cyclic Redundancy Check (CRC) code?
8. Explain about Checksum.

Multiple Access

1. Define Random Access and list three protocols in this category2. Write about ALOHA Protocols.
3. Write about CSMA protocol
4. Write about CSMA/CD protocol
5. Write about CSMA/CA protocol
6. Define controlled access and list three protocols in this category.

POWER ELECTRONICS SEMESTER – V			
Course Code:	**P21EE504**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40+24**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- To get overview of various types of power semiconductor devices, their control and switching characteristics.
- To understand the principle of operation, characteristics and performance parameters of controlled rectifiers and inverters.
- To get overview of various types of commutations and understand the various types of controllers.
- To study the operation and basic topologies of Ac-dc converters, Dc-Ac inverters, Dc-Dc Choppers and Ac-Ac voltage controllers.

UNIT – I	**Power Semiconductor Devices**	**08Hours**

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 component:	Peripheral effects and their remedies

1. **Source material to be referred**: 1.1.1-1.12-1.1.3-1.1.1.4-1.1.5-1.5.1-1.5.2-1.6.3-1.7.4 indicated Textbook 1, Chapter 1, Concept 1 in chapter 1.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation

Practical Topics:	a. Static characteristics of MOSFET and IGBT b. Speed control of Universal motor /single phase Induction motor.

UNIT – II	**Thyristors**	**08 Hours**

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 component:	Thyristor Gate Characteristics.

Source material to be referred: 1.3.1-1.3.2-1.3.3- 1.3.4-1.3.5 indicated Textbook 1.,Chapter 3, concept1, in chapter 2.

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, smart board

Practical Topics:	a. Static characteristics of SCR and TRIAC b. Experiment-SCR turn on using synchronized UJT relaxation oscillator

UNIT – III	**Thyristor Commutation Techniques& AC Voltage Controllers**	**08 Hours**

Introduction, Commutation - natural, forced, impulse, resonant pulse & complementary

Introduction, Principle of ON-OFF control, Principle of phase control - single phase and bi-directional controller with resistive load.	
Self-study component:	Self Commutation
1. **Source material to be referred**: 2.5.1-2.5.5 indicated Textbook 2., Chapter 5, Concept 1 1.18.1-1.18.2 indicated Textbook 1., Chapter 18, Concept 1 2. **Learning Validation method:** Compulsory Unit test 3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.	
Practical Topics:	a. AC Voltage Controllers using Triac-Diac combination b. Study of Commutation circuits.

UNIT – IV	**DC Choppers & Inverters**	**08 Hours**

Introduction, Principle of step-down and step-up choppers, Chopper classifications and their operations Introduction, Principle of operation, Single phase half &full bridge inverters, Analysis of single phase inverters, 3phase voltage source inverters.

Self-study component:	Performance parameters
1. **Source material to be referred**: 2.7.1-2.7.2-2.7.3-2.7.4-2.7.1-2.7.2-2.7.3-2.8.1-2.8.2 indicated Textbook2, Chapter 1, Concept 1 in chapter 1. 2. **Learning Validation method:** Compulsory Unit test 3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.	
Practical Topics:	a. Chopper operation with constant and variable Frequency Control. b. Single phase PWM inverter-IGBT Based

UNIT – V	**Controlled Rectifiers**	**08 Hours**

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 component:	Dual converters
1. **Source material to be referred**: 2.6.1-2.6.2-2.6.3-indicated Textbook 2., Chapter 1, Concept 1 in chapter 1. 2. **Learning Validation method:** Compulsory Unit test 3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.	
Practical Topics:	a. Single phase Half control bridge rectifier operation with R-load & Motor load. b. Single phase Full control bridge rectifier operation with R-Load & Motor load

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic science to study various types of semiconductor devices, their control of	Applying	L3

	converters.		
CO2	Develop and Design thyristor firing circuits and its commutation techniques	Applying	L4,L6
CO3	Analyze various types of converter circuits	Analyzing	L4
CO4	Examine the single/three phase circuits of the inverter.	Analyzing	L4
CO5	Conduct experiments on semiconductor devices and various types of converter/inverter circuits.	Analyzing	L4

TEXT BOOKS:-

1. Rashid, Power Electronics , Prentice Hall India Pvt Ltd, 4th edition,2016.
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.-2012
2. M.D. Singh &Kanchandoni,"Power Electronics", TMH Publishers Company, reprint 2014

Web and Video link(s):

1. https://www.youtube.com/watch?v=djbJm-xWo2w
2. https://www.youtube.com/watch?v=8_fsVsQia9o&list=PLgwJf8NK-2e5Hnu82T1CYLZ8kbZs4Jx8x
3. https://www.youtube.com/watch?v=1_7jCgTU1Ks
4. https://www.youtube.com/watch?v=EEETzABZ8Sc
5. https://www.youtube.com/watch?v=ZbvWe9xBu3Q&list=PLp6ek2hDcoND7i5-DAD9mPmYF1Wg6ROdO

E-Books/Resources:

- **https://www.electronics-tutorials.ws/premium/power-electronics-ebook.html**
- **https://www.powerelectronicsnews.com/category/ebook/**
- **https://www.springer.com/series/6403.**

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	PSO1	PSO2
1	Apply the knowledge of basic science to study various types of semiconductor devices, their control of converters.	3		-	-	-	-	-	-	-	-	-	2		2
2	Develop and Design thyristor firing circuits and its commutation techniques	3	-	1	-	-	-	-	-	-	-	-	-	-	2
3	Analyze various types of converter circuits	-	3												
4	Examine the single/three phase circuits of the inverter.	-	3	-	-	-	-	-	-	-	-	-	-	-	2
1-Low		**2-Medium**											**3-High**		

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 an half wave rectifier?
50. How in full bridge converter the role of converter and inverter can be interchanged

Power Plant Engineering SEMESTER – V			
Course Code:	**P21EEO5051**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the conceptual working principles of conventional sources of electric power generation.
- Explain the detail description of hydroelectric plants, Thermal Power Plant, nuclear power plants and Diesel power plants.
- Analyze the power generation using non-conventional energy sources.
- Understand the concept of load curves and different tariff.
- Understand the concept of grounding and power factor.

UNIT – I	**Hydro and Thermal Electric Station**	**08 Hours**

Hydro Electric Station: Introduction, Selection of site, Classification of hydro-electric plants, General arrangement and operation, Power station structure, layout& control.

Thermal Station: Introduction, Main parts and Working, Plant layout, Fuel handling system, Ash disposal schemes.

Self-study component:	Principle of working of a Hydro – Electric Turbines

1. **Source material to be referred**:1 indicated Textbook 1, Chapter 3,Concept 3.1,3.3,3.5,3.6,3.13 Chapter 2, Concept 2.1,2.2,2.4,2.6
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – II	**Nuclear Electric Station**	**08Hours**

Nuclear Power Station: Introduction, Selection of site, Plant Layout, Main parts of Reactor, Nuclear reactor classification, Effects of radiation on Human beings and the biosphere, Safety of nuclear power reactors, Pros and Cons of Nuclear Power Generation.

Self-study component:	Nuclear materials

1. **Source material to be referred**: 2 indicated Textbook 2, Chapter 7, Concept 7.1,7.3,7.4,7.12,7.14; 1indicated Textbook 1, Chapter 4, Concept 4.7,4.10;
2. **Learning Validation method:** Compulsory Unit tes
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – III	**Diesel Electric Station and Gas turbine plants**	**08 Hours**

Diesel Electric Station: Introduction, Main Components, Choice and characteristics, Plant layout and maintenance, advantages, disadvantages and applications of diesel power plant.

Gas Turbine Power Plant: Introduction, A simple gas turbine plant, Methods to improve thermal efficiency of gas turbine plant, Open cycle and Closed cycle gas turbine power plants.

Self-study component:	Integrated Gasification Combined-Cycle Plant

1. **Source material to be referred**: 1indicated Textbook 1,Chapter 5, Concept 5.1,5.2,5.4,5.6; Chapter 6, Concept 6.1 to 6.4
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – IV	**Non-Conventional Energy Sources and Economic Aspects**	**08 Hours**

Generation Using Non-Conventional Energy Sources: Wind, Solar, Tidal, Geo-thermal, Biomass Power

Economic Aspects: Introduction, Terms commonly used in system operations: Diversity factor, Load factor, Plant capacity factor, Plant use factor, Plant utilization factor, Loss factor, reserves, Power factor improvement and Tariffs.

Self-study component:	Cogeneration and Distributed generation

1. **Source material to be referred**: 2 indicated Textbook 2,Chapter 2, Concept 2.2,2.3,2.5,2.6,2.7 Chapter 4, Concept 4.1,4.2,4.4,4.5,4.7
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – V	**Substations and Grounding Systems**	**08 Hours**

Substations: Introduction, Substation equipments, types of Substations, Bus-Bar arrangements.

Grounding Systems: Introduction, Neutral grounding, Ungrounded System, Resonant grounding,Solid grounding, Resistance grounding, Reactance grounding, Earthing transformer, Neutral grounding Practice.

Self-study component:	Substation Bus Schemes

1. **Source material to be referred**: 2 indicated Textbook 2, Chapter 18,Concept 18.1,18.2,18.3,18.6 ;Chapter 19, Concept 19.1, 19.4 to 19.11.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic electrical engineering to study operating principle and classification of various power generation systems	Apply	L3
CO2	Analyze the selection criteria for power station sites and their layout, structure and maintenance of power plant	Analyze	L4

CO3	Analyze the economic aspects of power generation and significance of grounding in electrical systems.	Analyze	L4
CO4	Evaluate the economic aspects in power generation with different operational parameter	Evaluate	L5

Text Book(s):

1. A.Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, "POWER SYSTEM ENGINEERING", Dhanpat Rai& Co., 2nd edition 2010.
2. S. M. Singh, "Electrical Power Generation, Transmission and Distribution"-PHI Private Limited,New Delhi, 2nd edition 2010.

Reference Book(s):

1. M.V. Deshapande, "Electrical Power System Design" T.M.H., 1993.
2. C.L. Wadwa, "Electrical Power System", Wiley Stern.2000.

Web and Video link(s):

- https://archive.nptel.ac.in/courses/112/107/112107291/
- https://www.youtube.com/watch?v=3dJAtHaSQ98
- http://www.tatapower.com/businesses/renewable-energy.aspx
- http://www.cleanlineenergy.com/technology/wind-and-solar
- https://www.youtube.com/watch?v=kbuLfXgw4Gs
- https://www.youtube.com/watch?v=r9q80sSHxKM

E-Books/Resources:

- https://easyengineering.net/power-plant-engineering-books/
- http://www.gammaexplorer.com/wp-content/uploads/2014/03/Power-Plant-Engineering.pdf

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	PS O1	PS O2
1	Apply the knowledge of basic electrical engineering to study operating principle and classification of various power generation systems	3	-	-	-	-	-	1	-	-	-	-	2	2	-
2	Analyze the selection criteria for power station sites and their layout, structure and maintenance of power plant	-	3	-	-	-	1	-	-	-	-	-	1	2	-
3	Analyze the economic	-	3	-	-	-	2	-	-	-	-	-	1	2	-

	aspects of power generation and significance of grounding in electrical systems.														
4	Evaluate the economic aspects in power generation with different operational parameter	-	3	-	-	-	-	-	-	-	-	-	-	2	-
1-Low						**2-Medium**							**3-High**		

Assignment Questions

1. Show that the average power in a hydel station is given by**,** P=3.14nK AFH x 10-4 kW, when A = Catchment area in sq. km,F = Annual rainfall in mm, H = Effective head in mt, n = plant efficiency, K = Yield factor.
2. A river based hydel plant has its capacity as "firm capacity" when it operates at the peak part of the load curve, the load factor here being 15%. If the rated installed capacity of the generator, head and plant efficiency are 10 MW, 50 mt and 0.8 respectively, calculate the minimum flow of river water in order to operate the plant at the base part of the load curve.
1. The relation between water evaporated (M kg), coal consumption (C kg), and energy generated (kWh) for 8 hour shift in a thermal power plant is given by
2. M=15,000+ 10 kWh ; C = 5,000 + 5 kWh
    (a) To what limiting value does the water evaporation per kg of coal consumed approach as the station output increases?
    (b) How much coal per hour would be required to keep the station running at no load?
3. A thermal power plant spends Rs 25 lakhs in one year as coal consumption. The coal has heating value of 5000 kcal/kg and costs Rs 500 per ton. If the thermal efficiency is 35% and electrical efficiency is 90%, find the average load on the power plant.
4. How you will explain mechanism of energy release in a nuclear reaction?
5. What are the types of nuclear reaction? Describe briefly.
6. Write short notes on:
    (i) Efficiency of diesel electric plant.
    (ii) Auxiliary equipments in diesel electric plant.
    (iii) Maintenance and plant layout of a diesel electric station.
7. An industrial load can be supplied on the following alternative tariffs:
    (a) H.V. supply at Rs. 60 per kVA per annum plus 3 p per kWh
    (b) L.V. supply at Rs. 65 per kVA per annum plus 3.3 p per kWh
8. A certain plant has fixed cost of Rs. 4x 104 and a salvage value of Rs. 4× 103 at the end of a useful life of 20 years. What would be the valuation half way through its life based on

(a) Straight line depreciation method
(b) Reducing balance depreciation method
(c) Sinking fund depreciation at 6% compounded interest of 6% me annually?

9. Define the term Diversity factor and prove that the load factor of a supply system is improved by an increase diversity of load.
10. Determine the value of inductance of arc suppressor coil to be connected between the neutral and ground to neutralize the charging current of overhead line having the line to ground capacitance equal to 0.2 μF. If the supply frequency is 50 Hz and the operating voltage is 132 kV find the KVA rating of the coil.
11. A 220-kV, 3-phase, 50-Hz transmission line of 150 km consists three conductors equilaterally spaced with 7 m and having effective diameter of 3 cm. Find the inductance and MVA rating of the Peterson coil in the system.
12. Line-to-ground capacitance of an overhead transmission line operating at 50 Hz is 1 μF. Find the reactance to neutralize the capacitance of:
    (a) 100% of the line length
    (b) 95% of the line length
    (c) 90% of the line length.
13. What are the applications of a gas turbine power plant?
14. What are the fuels for gas turbine power plant?

Review questions

1. Write a brief note on site selection and classification of the site for hydroelectric power generation.
2. Explain main components of hydroelectric power plants.
3. With a neat diagram, explain four main flow circuits of steam power plant.
4. Explain the main parts of steam power plant.
5. Explain the coal handling and ash disposal schemes for thermal power plant.
6. Write a brief note on site selection nuclear power station.
7. Explain main components of reactors of the nuclear power plants.
8. With a neat diagram, explain boiling water reactor (BWR) and pressurized water reactor (PWR).
9. What are the effects of radiation on human beings and the biosphere?
10. What are the types of diesel plants? Explain the components of diesel electric station.
11. Write a brief note on choice & characteristic of the diesel station.
12. Write a note on solar water heating arrangement.
13. With a neat schematic diagram, write a note on solar power plant.
14. List out & explain the components of wind power plant.
15. What are the different schemes for harnessing tidal energy?
16. Write a note on distributed generation.
17. What are all the common factors which are normally used in electricity system planning, operation and management?
18. Explain diversity factor and plant capacity factor.
19. What are the several measures by which low power factor can be avoided?
20. Explain two ways of improving power factor.
21. What are the main objectives in framing a tariff?
22. What are the main neutral grounding practices?
23. Explain the resistant grounding system and obtain an expression for screening coefficient for n electrodes.
24. What is neutral grounding? What are the advantages of neutral grounding?
25. Define resonant grounding. With a neat phasor diagram, explain 3-phase isolated neutral system.
26. Write a note on reactance grounding and resistance grounding.
27. Explain the general arrangement and operation of a hydro-electric plan?
28. Draw the schematic layout of a typical thermal power plant?
29. Explain the working of boilers?
30. What are the effects of low power factor and what are the methods of improving power factor?
31. Derive an expression for the most economical power factor?
32. With neat sketch explain the function of any two coal handling system?
33. Discuss base load and peak load power plants?
34. What do you understand by electrical tariff? Discuss two and three part tariff and power factor tariff.
35. With neat sketch explain working of gas turbine power plant?

36. Draw flow diagram of diesel power station and discuss its operation.
37. Discuss concepts of co-generation, its merits and demerits.
38. With diagram explain the working of tidal power plant?
39. State the advantages of operating the power plants combined in electric power system?
40. Explain high head and base load power plant.
41. Explain the methods of nuclear waste disposal.
42. Explain the main parts and operation of thermal power plant.
43. Enumerate and explain the parts of a nuclear reactor.
44. Describe the construction and working of pressurized water reactor.
45. With neat sketch explain working of open cycle gas turbine.
46. Discuss advantages of gas turbine power plant over thermal power plants.
47. Explain how hydro-electric plants are classified.
48. What are the factors to be considered for selection of site for thermal power plant?
49. What are the factors to be considered for selection of site for hydro power plant?
50. What are the factors to be considered for selection of site for nuclear power plant?

Renewable Energy Sources SEMESTER – VI			
Course Code:	**P21EEO5052**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Appreciate the importance of various types of energy sources and understand the need for studying renewable energy sources.
- Understand the various types of conversion methods of solar radiations into heat and know the various types of solar collectors and applications.
- Know the significance of wind energy, biomass energy and understand the basic principles and the various types of biomass conversion technologies.
- Understand the relevance of various types of ocean and tidal energy conversion systems and to know the different types of arrangements and applications
- Understand the concept of Green Energy and to know the significance of Hydrogen Energy.

UNIT – I	**Energy Sources**	**7 Hours**

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

Self-study component:	Comparison of Conventional and Non-Conventional Energy

Source material to be referred: 1.1.1, 1.1.2, 1.1.4, 1.1.6, 1.1.8, 1.1.9, 1.1.10, 1.1.11, 1.1.14,
Learning Validation method: Compulsory Unit test
Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – II	**Solar Energy Basics**	**8 Hours**

Solar Energy: Solar Radiation Fundamentals, Solar radiation Measurements- Pyrheliometers, Pyrometer.

Solar Thermal systems: Flat plate collector; Solar pond electric power plant.

Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.

Self-study component:	Principle of Conversion of soar radiation into heat

Source material to be referred: 1.2.2, 1.2.3, 1.2.6, 1.3.1,1.3.3, 1.3.8,1.4.3,1.5.6

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – III	**Wind and Biomass Energy**	**8 Hours**

Wind Energy: Introduction, history of wind energy, Basic principle of Wind energy conversion system(WECS), classifications of WECS, part of a WECS, wind site selection consideration, advantages & disadvantages of WECS

Biomass Energy: Introduction; Biofuels; Biomass conversion technologies ; Factors affecting

Biodigestion, Urban waste to energy conversion; Biomass gasification (Downdraft)	
Self-study component:	Wind and its property , Photosynthesis Process

Source material to be referred: 1.6.1, 1.6.2, 1.6.4, 1.6.5, 1.6.6, 1.6.7, 1.6.8,1.7.1, 1.7.2, 1.7.1,1.7.5, 1.7.9, 1.7.10

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – IV	**Energy from Ocean**	**8 Hours**

Tidal Power: Tides and waves as energy suppliers and their mechanics; Components of Tidal power plant, fundamental characteristics of tidal power,harnessing tidal energy, advantages and limitations.

Ocean Thermal Energy Conversion: Introduction , Principle of working, Methods of OTEC power generation-open cycle(Claude Cycle) and closed cycle(Anderson cycle).

Self-study component:	Principle of Tidal Energy

Source material to be referred: 1.9.1, 1.9.2, 1.9.3

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – V	**Green Energy**	**9 Hours**

Green Energy: Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage – compressed gas storage and liquid storage, applications of hydrogen energy, problem associated with hydrogen energy.

Self-study component:	Hydrogen Transportation

Source material to be referred: 1.10.1, 1.10.2, 1.11.1, 1.11.2, 1.11.3, 1.11.5

Learning Validation method: Compulsory Unit test

Pedagogy method used: chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**
CO1	Apply the knowledge of basic science to study non conventional energy sources.	Remember
CO2	Analyze the various non conventional energy sources.	Understand
CO3	Solve numerical problems on non conventional energy systems	Apply
CO4	Conduct a survey on performance of real-world renewable energy plant.	Analyze

Text Book(s):

1. Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2. Khan B H, Non-conventional energy resources, TMH, New Delhi,2006.

Reference Book(s):

1. Principles of Energy conversion, A. W. Culp Jr.,, McGraw Hill, 1996
2. Non-Conventional Energy Resources, Shobh Nath Singh, Pearson, 2018
3. Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication.Solar energy, Subhas P Sukhatme, Tata McGraw Hill, 2nd edition

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc18_ge09/preview

E-Books/Resources:

1. E-book URL: https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html
2. E-bookURL:https://www.pdfdrive.com/non-conventional-energy-systems-npteld17376903.html
3. E-book URL: https://www.pdfdrive.com/renewable-energy-sources-and-their-applicationse33423592.html
4. E-book URL: https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sourcese34339149.html

Course Outcome – CO		Program Outcome													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of basic science regarding non conventional energy sources.	3											2	1	
2	Analyze the various non conventional energy sources.		3											1	
3	Evaluate non conventional energy systems using numerical methods.		3											1	
4	Analyze real-world case studies related to renewable energy sources.		3		1		2	1		2	2		2	1	

Review questions

1. What are primary and secondary energy sources?
2. What are the conventional and non-conventional energy sources?
3. Explain per capita energy consumption.
4. Discuss briefly the possibilities of utilizing the following methods of power

generation:
   (i) Solar energy
   (ii) Magneto hydrodynamics
   (iii) Fuel cells.

5. Write short notes on:
   (i) Wind energy
   (ii) Tidal energy
   (iii) Bio-mass and bio-gas
   (iv) OTEC
6. What are the prospects of non-conventional energy sources in India? Explain.
7. What is meant by renewable energy sources?
8. What are the advantages of renewable energy sources?
9. What are the limitations of renewable energy sources?
10. What are the main components of a flat-plate solar collector, explain the function of each?
11. How solar air collectors are classified?
12. Enumerate the different types of concnetrating type collectors.
13. Enumerate the different applications of solar energy.
14. With the help of a neat sketch describe a solar air heating collector system.
15. What are the main components of a flat plate collector.
16. What are the advantages and disadvantages of concentrating collectors over a flat-plate collectors?
17. What is the principle of solar photovoltaic power generation?
18. What are the main elements of a PV system?
19. With a diagram explain the Grid integrated solar PV System.
20. What are the advantages and disadvantages of photovoltaic solar energy conversion?
21. What is the basic principle of wind energy conversion?
22. Describe the main considerations in selecting a site for wind generators.
23. Describe with a neat sketch the working of a wind energy system (WECS) with main components.
24. How are WEC systems classified? Discuss in brief.
25. Discuss the advantages and disadvantages of wind energy conversion system?
26. Describe the main applications of wind energy system.
27. What is biomass?
28. Write a note on the classification of Biomass Resources.
29. List the factors that affects biodigestion.
30. Explian the following terms with respect to Biomass conversion Process.
    a) Fermentation
    b) Anaerobic digestion
    c) Thermal Conversion
31. With a diagram explain the KVIC Model of Biogas plant.
32. With a diagram explain the Janatha Model of Biogas plant.
33. Write a note on Biomass Programs in India.

34. Explain the different schemes used to generate power from Tidal Power Plant.
35. Write a brief description on different components of Tidal Power Plant?
36. What are the difficulties in tidal power developments?
37. What is the basic principle of ocean thermal energy conversion?
38. Explain the open cycle OTEC system with a neat diagram.
39. Describe the 'closed cycle' OTEC system with a neat diagram.
40. Enumerate the advantages of Closed cycle OTEC system over 'open cycle' OTEC system.
41. What is a Fuel Cell?
42. Write a note on classification of Fuel Cells.
43. Explain the operation of H_2O_2 Fuel cell.
44. Explain Zero Energy Concepts.
45. Explain the benefits of Hydrogen Energy.

Fuzzy Logic Control SEMESTER – V			
Course Code:	**P21EEO5053**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course aims is to:

- To understand the properties and relations of fuzzy sets
- To get the knowledge of different methods of membership function.
- To study different variables and rules of fuzzy system
- To understand the operations of fuzzy logic control system
- To study the different rules, membership functions used in fuzzy knowledge based controllers

UNIT – I	**Introduction**	**8 Hours**

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 component:	Obtain the Examples of fuzzy sets for different engineering applications

1**. Source material to be referred**: Textbook 1: 7.1 to 7.3 & 8.1 to 8.3 and
Textbook 2 : Chapter 2 & 3

2**. Learning Validation method:** Group Activities

3**. Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – II	**Membership functions**	**8 Hours**

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 component:	Write MATLAB programs for the different Fuzzification, and Defuzzification methods

1**. Source material to be referred**: Textbook 1: 9.1 to 9.4 & 10.1 to 10.4. and
Textbook 2 Chapter 4.:

2**. Learning Validation method:** Group Activities

3**. Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – III	**Theory of approximate reasoning**	**8 Hours**

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 component:	Detailed study and make Comparisons between Mamdani and Sugino methods.

1**. Source material to be referred**: Textbook 1: 12.1 to 12.8
2**. Learning Validation method:** Group Activities
3**. Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – IV	**Fuzzy Logic Control system**	**8 Hours**

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 component:	Applications of FLC systems.

1**. Source material to be referred**: Textbook 1: 14.1 to 14.7.
2**. Learning Validation method:** Group Activities
3**. Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – V	**Fuzzy knowledge based controllers (FKBC)**	**8 Hours**

Basic concept structure of FKBC, Choice of Membership Functions, Scaling Factors, Rules, Fuzzyfication and Defuzzyfication Procedures.

Self-study component:	Simple Applications of FKBC

1**. Source material to be referred**: Textbook 2: Chapter 14
2**. Learning Validation method:** Group Activities
3**. Pedagogy method used:** Chalk and talk, Power point presentation, case study.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of properties fuzzy sets to the control systems	Apply	L3
CO2	Analyze the different types fuzzy relations with different methods of membership function in fuzzification and defuzzification.	Analyze	L4
CO3	Examine theory of approximate reasoning with different fuzzy rules	Analyze	L4
CO4	Compute the fuzzy sets with different membership function	Apply	L3

Text Book(s):

1. "Principles of Soft Computing", S N Sivanandam and S N Deepa, 2nd edition, 2011, ISBN: 978-87-265-2741-0
2. "Fuzzy Logic With Engineering Applications", TimotyRoss,John Wiley, Second Edition,

2009. ISBN 0-470-86074-X (Cloth), 0-470-86075-8 (Paper).

Reference Book(s):

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.
4. An Introduction to Fuzzy Control, by: D. Diankav, H. Hellendoom and M. Reinfrank Narosa Publishers India, 1996.

E-Books/Resources:

- http://home.iitk.ac.in/~avrs/ManyValuedLogic/FuzzyLogicforEngineers.pdf

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	PSO2
1	Apply the knowledge of properties of fuzzy sets to the control systems	3	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Analyze the different types of fuzzy relations with different methods of membership function .	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	Examine theory of approximate reasoning with different fuzzy rules	-	3	-	-	-	-	-	-	-	-	-	-	-	-
4	Compute the fuzzy sets with different membership function	-	3	-	-	3	-	-	-	1	-	-	1	-	-
1-Low		**2-Medium**											**3-High**		

Review Questions

1.Define classical sets and fuzzy sets.
2. State the importance of fuzzy sets.
3. What are the methods of representation of a classical set?
4. Discuss the operations of crisp sets.
5. List the properties of classical sets.
6. What is meant by characteristic function?

7. Write the function theoretic form representationof crisp set operations.
8. Justify the following statement: "Partial membership is allowed in fuzzy sets."
9. Discuss in detail the operations and properties of fuzzy sets.
10. Represent the fuzzy sets operations using Venn diagram.
11. What is the cardinality of a fuzzy set?Whether a power set can be formed for a fuzzy set?
12. Apart from basic operations, state few other operations involved in fuzzy sets.
13. Compare and contrast classical logic and fuzzy logic.
14. Why the excluded middle law does not get satisfied in fuzzy logic?
15. Describe the importance of fuzzy sets and its application in engineering sector.
16.Define classical relations and fuzzy relations
17. How are the relations represented in various forms?
18. State the Cartesian product of a relation
19.Compare constrained relation and constrained relation and non-constrained relation
20. Mention the operations performed on classical relations.
21. List the various properties of crisp relations.
22. Define fuzzy matrix and fuzzy graph.
23. Give the cardinality of fuzzy relation.
24.Explain the operations and properties over a fuzzy relation
25. Discus fuzzy composition techniques.
26.Explain with suitable diagrams and examples of fuzzy equivalence relation.
27.What is meant by noninteractive furry sets?
28.Define membership function and state its importance in fuzzy logic
29. Explain the features of membership functions
30. Differentiate the between Convex and nonconvex fuzzy set and Normal and subnormal fuzzy set
31. Write short note on fuzzification.
32.List the various methods employed for the membership value assignment.
33.Define defuzzification and State the necessity of defuzzification process.
34.Write short note on lambda-cut for fuzzy sets
35. List the properties of lambda-cut for fuzzy sets .
36.Mention the properties of lambda-cut for fuzzy relations
37.What are the different methods of defuzzification process?
38.Compare first of maxima and last of maxima method.
39.What is the difference between centroid method and center of largest area method?
40. State the importance of a control system.
41. What are the two types of control systems?
42. Differentiate between open-loop and closed-loop control systems.
43. Mention the four structures of fuzzy production rule system.
44. With a neat block diagram, explain the architecture of a fuzzy logic controller.
45. What are the steps involved in designing a fuzzy logic controller?
46. Mention the features of a simple FLC system.
47. What are the special forms of FLC system models?
48. With a suitable application case study explain a fuzzy logic controller.

Course Title: ILLUMINATION ENGINEERING SEMESTER V			
Course Code:	**P21EO5054**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives (CLOs)

This course is aim is to

- Understand the different sources and energy radiation of lights
- Understand the different measuring types and types of lights
- Understand the different lighting parameters and design of luminance

UNIT – I	**Introduction**	**8 Hours**
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		
Self-study component:	Dependence of light output on temperature	
UNIT – II	**Measurement of light**	**8 Hours**
: Radiometric and photometric quantities, units of measurement, standardization. Measurement of light distribution, direct and diffused reflection, fundamental concepts of colourimentry.		
Self-study component:	Measurement of colour. .	
UNIT – III	**Types of lamps**	**8 Hours**
GLS, Tungsten - halogen, Discharge, low pressure sodium vapour fluorescent, metal - halide, IR and VV lamps - their construction, filament material, theory of operation, life, characteristics.		
Self-study component:	Applications of various lamps	
UNIT – IV	**Design, objectives and specifications of lighting and systems**	**8 Hours**
Design of luminance, basic lighting design, consideration and lighting parameters for extension lighting, interior lighting and day lighting.		
Self-study component:	Electrical circuits and auxiliaries	
UNIT – V	**Energy conservation in lighting**	**8 Hours**
Perception of light and colour, optical system of human eye, eye as visual processor. Reflection, refraction.		
Self-study component:	Behaviour of light	

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic science to study different	Apply	L3

	sources of light		
CO2	Analyze different types of lightening schemes and lamps.	Analyze	L4
CO3	Design of lighting systems and determine different lighting parameters	Design	L5
CO4	Inspect a case study on different lighting systems	Analyze	L4

Text Book:

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

Reference Books:

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

Course 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 different sources of light	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	Analyze different types of lightening schemes and lamps.	-	3	-	-	-	-	-	-	-	-	-	-	2	-
3	Design of lighting systems and determine different lighting parameters	-	-	3	-	-	-	-	-	-	-	-	-	2	-
4	Inspect a case study on different lighting systems	3	3	-	-	-	-	-	-	-	-	-	2	2	-

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

Course Title: Circuit Simulation & Auto CAD Laboratory SEMESTER – V			
Course Code:	**P21EEL506**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0:0:2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**18**	**SEE Marks:**	**50**

This course aims to

- To conduct practical experiments on circuits and measuring instruments, KCL & KVL for multi loop electrical circuits, Thevenin's theorem, Maximum Power Transfer Theorem, clipping & clamping circuits
- To analyze and to draw the single line diagram of stations.
- To analyze and to draw the layout diagram of some generating stations.
- To design the winding diagrams of D.C. machines Simplex single layer Lap and wavewinding.
- To design the winding diagrams of D.C. machines Simplex double layer Lap and wave winding.
- To design the winding diagrams of D.C. machines Duplex single layer Lap and wave winding.

Sl.No	List of Experiments	No. of .Hours
1.	Verification of KCL & KVL for multi loop electrical circuits, with DC & AC sources using PSPICE.	**2**
2.	Verification of Thevenin's theorem using PSPICE	**2**
3.	Verification of Maximum Power Transfer Theorem using PSPICE	**2**
4.	RC coupled amplifier-Frequency response & determination of bandwidth using PSPICE.	**2**
5.	Bridge rectifier, Diode clipping & clamping circuits using PSPICE.	**2**
6.	Draw Single Line Diagrams of substation.	**2**
7.	Develop winding diagrams of D.C. machines Simplex single layer Lap and wave winding.	**2**
8.	Develop winding diagrams of D.C. machines Simplex double layer Lap and wave winding.	**2**
9.	Develop winding diagrams of D.C. machines Duplex single layer Lap and wave winding.	**2**
10.	Develop winding diagrams of D.C. machines Duplex double layer Lap and wave winding.	**2**
11.	Develop winding diagrams of A.C. machines Integral slot full pitched single layer Lap and Wave windings.	**2**
12.	Develop winding diagrams of A.C. machines Integral slot full pitched Double layer Lap and Wave windings.	**2**

Internship - II [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P21INT507**	**Credits:**	**02**
Teaching Hours/Week (L:T:P)	**0:0:0**	**CIE Marks:**	**-**
Total Number of Teaching Hours:	**-**	**SEE Marks:**	**100**

All the students registered to III year of BE shall have to undergo a mandatory internship of 04 weeks during the vacation of IV semesters in industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship/AICTE Internshala/College Partnered Industries. A Semester End Examination (Presentation followed by Question Answer session) shall be conducted during V semester and the prescribed credit shall be included in the V semester grade card. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent Semester End Examination after satisfying the internship requirements. (The faculty coordinator or mentor has to monitor the students' internship progress and interact to guide them for the successful completion of the internship.)

Internship-II: SEE component will be the only seminar/Presentation and question answer session

EMPLOYABILITY ENHANCEMENT SKILLS - V [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V for CSE, ISE, ECE, EEE & CSE(AIML) Branches only			
Course Code:	**P21HSMC508B**	**Credits:**	**01**
Teaching Hours/Week (L:T:P)	**0:2:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**30**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Calculations involving Time and work, Speed & distance, trains, boats and streams and races.
- Explain concepts behind logical reasoning modules of clocks and calendars.
- Develop problem solving skills through Data structures.

UNIT – I		**06 Hours**

Quantitative Aptitude: Time and Work, Time, Speed and Distance.

Logical Reasoning: Clocks and Calendars.

Self-study component:	Decimal fractions

UNIT – II		**06 Hours**

Quantitative Aptitude: Trains, Boats and Streams, Races.

Verbal Ability: Reading Comprehension, Critical Reasoning.

Self-study component:	Game based assessments

UNIT – III	**ADVANCED DATA STRUCTURES - I**	**06 Hours**

Priority Queues: Introduction to Priority Queues, Ways to implement priority queues, Introduction to heaps, Introduction to Complete Binary Trees and its implementation, Insert and Delete operations in heaps, Implementing priority queues, Heap sort, Inbuilt Priority Queue

Hashmaps: Introduction to Hashmaps, Inbuilt Hashmap, Hash functions, Collision handling, Insert and Delete operation implementation in hashmap, Load factor, Rehashing

Self-study component:	Applications of Queues: Josephus Problem

UNIT – IV	**ADVANCED DATA STRUCTURES - II**	**06 Hours**

Tries: Introduction to Tries, making a Trie Node class, Insert, Search and Remove operation implementation in Tries, Types of Tries, Huffman coding.

Graphs: Introduction to Graphs, Graph Terminology, Graph implementation, Graph Traversals (DFS and BFS), Weighted and Directed Graphs, Minimum Spanning Trees, Cycle Detection in

Graphs, Kruskal's algorithm, Prim's algorithm, Dijkstra's algorithm.		
Self-study component:	Optimal Binary Search Trees.	
UNIT – V	**ADVANCED DATA STRUCTURES - III**	**06 Hours**

Introduction to Dynamic Programming: Introduction to Memoization, Introduction to Dynamic Programming, Fibonacci numbers using recursion, memoization and dynamic programming

Applications of Dynamic Programming: Longest Common Subsequence (LCS) using recursion, memorization and dynamic programming, Edit distance using recursion, memorization and dynamic programming, Knapsack problem using recursion, memorization and dynamic programming

Self-study component:	Lower Bound Arguments, Decision trees.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Solve the problems based on Time and work, Speed & distance, trains, boats and streams and races.	Applying	L3
CO2	Solve logical reasoning problems based on Clocks and calendars and verbal ability skills of reading comprehension and critical reasoning.	Applying	L3
CO3	Analyze and represent various data structures and its operations.	Analyzing	L4
CO4	Develop programs with suitable data structure based on the requirements of the real-time applications	Applying	L3

Text Book(s):

1. Data Structures and Algorithms Made Easy by Narasimha Karumanchi
2. Data Structures through C in Depth by by S K Srivastava and Deepali Srivastava
3. Quantitative aptitude by Dr. R. S Agarwal, published by S. Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal, published by S. Chand private limited.

Reference Book(s):

1. Aaron M Tenenbaum, Yedidyah Langsam and Moshe J Augenstein, "Data Structures using C", 2014, low price edition ,Pearson education.
2. Seymour Lipschutz, Data Structures with C (Schaum's Outline Series) , July 2017, McGraw Hill Education.
3. Quantitative Aptitude by Arun Sharma, McGraw Hill Education Pvt Ltd.

Web and Video link(s):

1. Data Structures and algorithms offered by NPTEL:

https://nptel.ac.in/courses/106102064/
2. https://www.youtube.com/watch?v=CBYHwZcbD-s
3. https://www.youtube.com/watch?v=2ZLl8GAk1X4
4. https://www.youtube.com/watch?v=MdG0Vw9f1A4

COURSE ARTICULATION MATRIX
(EMPLOYABILITY ENHANCEMENT SKILLS - V– P22HSMC508B)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	1	1	2	-	-	-	-	-	-	-	-	1

Social Connect and Responsibility

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

Course Code:	**P21UHV509**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**1:0:0**	**CIE Marks:**	**100**
Total Number of Teaching Hours:	**25+5**	**SEE Marks:**	**--**

Course Outcomes: This course will enable the students to:

- **Identify** the needs of the community and involve them in problem solving.
- **Demonstrate** the knowledge about the culture and societal realities.
- **Develop** sense of responsibilities and bond with the local community.
- **Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.
- **Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions for individual and community problems.

PART-I

Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONE TREE) They will also make an excpert either as a documentary or a photo blog describing the plant's origin, its usage in daily life, its appearance in folklore and literature – Objectives, Visit, case study, report, outcomes.

PART-II

Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives, Visit, case study, report, outcomes.

PART-III

Organic farming and waste management: Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.

PART-IV

Water conservation: Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photoblog presenting the current practices – Objectives, Visit, case study, report, outcomes.

PART-V

Food walk: City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, case study, report, outcomes.

Course Outcomes: On completion of this course, students are able to:			
COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Identify** the needs of the community and involve them in problem **solving.**	**Knowledge / Apply**	**L1 & L3**
CO2	**Demonstrate** the knowledge about the culture and societal realities.	**Understand**	**L2**
CO3	**Develop** sense of responsibilities and bond with the local community	**Apply**	**L4**
CO4	**Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.	**Apply**	**L4**
CO5	**Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions for individual and community problems.	**Create**	**L6**

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE):

After completion of the social connect and responsibility course, the student shall prepare, with daily diary/ report as reference and a comprehensive report in consultation with the faculty/mentor to indicate what he has observed and learned in the social connect period.

The report shall be evaluated on the basis of the following below criteria's or other relevant criteria pertaining to the activity completed.

- Planning and scheduling the social connect.
- Information/Data collected during the social connect.
- Analysis of the information/data and report writing.
- Presentation and interaction.

CIE Rubrics for Evaluation.

Report	**Video presentation**	**Interaction**	**Total**
10	05	05	20

Note:

- Video presentation of **4 to 5 min** in a team to be presented and the same to be uploaded in the department YouTube channel.
- The number of students in each team can be from **4 to 5** members.
- Each activities has to be evaluated on above basis that is [20 * 5 = 100 marks] for final total marks.

Duration : A total of 25 – 30 hours engagement per semester is required for the 5th semester of the B.E./B.Tech. program. The students will be divided into groups and each group will be handled by faculty mentor.

Pedagogy – Guidelines:

Special Note: NO SEE – Semester End Exam – Completely Practical and activities based evaluation

It may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

Sl No	Topic	**Group size**	Location	**Activity execution**	**Reporting**	**Evaluation Of the Topic**
1.	**Plantation and adoption of a tree:**	May be individual or team	Farmers land/ parks / Villages / roadside/ community area / College campus etc…..	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
2.	**Heritage walk and crafts corner:**	May be individual or team	Temples / monumental places / Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
3.	**Organic farming and waste management:**	May be individual or team	Farmers land / parks / Villages visits / roadside/ community area / College campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty

4.	**Water conservation:** & conservation techniques	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers / campus etc…..	site selection / proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
5.	**Food walk: Practices in society**	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty

Computer Techniques in Power Systems SEMESTER – VI			
Course Code:	**P21EE601**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

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

UNIT – I	**Network Topology**	**08 Hours**

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

Self-study component:	program to calculate incidence matrices using software

UNIT – II	**Network Matrices**	**08 Hours**

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

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

UNIT – III	**Load Flow Studies**	**08 Hours**

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

Self-study component:	Program for power flow studies using software

UNIT – IV	**Economic Operation of Power System**	**08 Hours**

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

Self-study component:	Iterative technique to solve economic dispatch problems.	
UNIT – V	**Transient Stability Studies**	**08 Hours**

Transient Stability Studies: Factors affecting transient stability, Methods of improving transient stability, Swing equation, Numerical solution of Swing Equation – Point-by-point method, Modified Euler's method, Runge -Kutta method, Milne's predictor corrector method.

Self-study component:	Representation of power system for transient stability study

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of network topology to obtain different types of incidence matrices and network matrices.	Apply	L3
CO2	Analyze load flow studies, economic generation schedule and transient stability of a power system.	Analyze	L4
CO3	Solve the problems on load flow analysis, economic load dispatch and transient stability.	Analyze	L4
CO4	Solve the problems related to Power system using suitable software.	Apply	L3

Text Book(s):

Text Books:

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

Reference Book(s):

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

Web and Video link(s):

- https://youtu.be/pyvsQswswjQ
- https://www.youtube.com/watch?v=m3TcMnY61jU
- https://youtu.be/VT3zXZq7Alo

E-Books/Resources:

- https://www.academia.edu/15353264/Subject_COMPUTER_TECHNIQUES_IN_POWER_SYSTEMS_Code_EE72

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 network topology to obtain different types of incidence and network matrices.	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	Analyze load flow in power system using desired algorithm and economic generation schedule by considering specified constraint, methods to find solution of swing equation.	-	3	-	-	-	-	-	-	-	-	-	-	2	-
3	Apply the knowledge of load flow analysis, economic load dispatch and transient stability to solve the related problems.	3	-	-	-	-	-	-	-	-	-	-	-	2	-
4	Solve the problems related to Power system using suitable software.	-	3	-	-	3	-	-	-	-	-	-	-	2	-
1-Low 2-Medium 3-High															

Review Questions

1. With a neat sketch define (i) tree and co-tree (iii)Basic loops and Basic cut sets (iii)Primitive networks
2. Define (a)branch-path incidence matrix and (b)basic loop incidence matrix
3. Give dimensions of the matrices: Acap, Bcap
4. Branch path incidence matrix K and incidence matrix A are related by: ----------
5. What are primitive networks and Obtain the performance equations in both impedance and
   a. admittance form.
6. For the given oriented connected graph of the system shown in figure, Obtain (i) Basic cut set incidence matrix, B (ii)Basic loop incidence matrix C. Select elements 5,6 and 7 as links . Hence verify the relation $C_b = -B_l^t$
7. The bus incidence matrix, A, of 8-elements, 5-node system is given below. Obtain the element node incidence matrix and the oriented graph. From the graph, write the Basic loop incidence matrix C and Basic cut set matrix B. The columns represent elements.

1	0	0	0	-1	0	1
0	0	0	1	0	0	-1
0	1	0	0	1	1	0
0	0	1	0	0	-1	0

8. Derive an expression for obtaining the bus admittance matrix using singular transformations.

9. Determine the bus admittance matrix Y_{bus} using the singular transformations for the sample power system with the line data shown in table below. Line charging admittances are assumed to be zero

Line No.	1	2	3	4	5	6
Bus-code p-q	1 - 2	1 - 3	2 -3	1 - 0	2 – 0	3 – 0
Impedance (pu)	0.24	0.15	0.18	0.0	0.0	0.0

10. What are different types of buses considered during power system load flow analysis? Explain briefly.
11. Determine the voltages at the end of first iteration using Gauss Seidal method for the system data given below. Assume an acceleration factor of 1.

i) Line Data

Bus Code	1 - 2	1 - 3	2 - 3	2 - 4	3 - 4
Admittance	2 – j 8	1 – j 4	0.66– j 2.664	1 – j 4	2 – j 8

ii) Bus Data

Bus No.	P	Q	V	Remarks
1	-	-	1.06@0	SLACK
2	0.5	0.2	1+ j 0	PQ
3	0.4	0.3	1+ j 0	PQ
4	0.3	0.1	1+ j 0	PQ

12. How tap changing transformers are represented in load flow studies for formation of Ybus matrix.
13. Derive the expression in polar form for the typical diagonal elements of the sub matrices of the Jacobian in the Newton Raphson method of load flow analysis.
14. Compare NR and GS method LFS procedure in respect of the following
    (i)Time per iteration
    (ii) Total solution time
    (iii) Acceleration of convergence of iterative solution.
15. Write brief notes on the following:
    (i) Representation of tap changing of transformers in load flow studies
    (ii) Fast decoupled load flow analysis
16. Explain the input – out curves and other performance curves of thermal plant.
17. Explain LaGrange's method of solution of economic schedule.
18. Derive the expression for economic scheduling including transmission losses.
19. What is penalty factor ? Explain.
20. Explain the iterative technique for solution of economic dispatch with losses.
21. Give the flow chart solution of incremental fuel cost by iterative technique.
22. The fuel cost curves of two plants, i.e for plants 1 and 2 are given by:
    $F1 = 0.1\ P_1^2 + 20\ P1 + 100$ Rs./Hr.
    $F2 = 0.1\ P2^2 + 30P2 + 150$ Rs./Hr.
    If the total demand is 200MW, find the optimum generator schedules and IFC (λ), when transmission losses are neglected. If the load is equally shared by both the units, determine the IFCs (λ).
23. The incremental fuel costs inRs/MWH for plants 1 and 2 are given by:$dF1/dP1 = 0.18\ P1+30$ (with $25 \leq P1 \leq 125$ MW). $dF2/dP2 = 0.2\ P2 + 12$ (with $25 \leq P1 \leq 125$ MW). Total load varies from 50 t0 200 MW. How will the load be shared between the two units as the system load varies over the full range in steps of 50MW? What are system λ – values ?
24. What are transmission line loss coefficients? Obtain the general expression Bmn with usual notations.
25. For the system shown in the fig.(2), with bus1 as ref. bus with voltage $1.0 \angle 0^0$ p.u find the B-coefficients B_{mn}, if the load currents I_{L1}, I_{L2} and tie line I_{21} are given as : I_{L1} = (1.0-j0.2) p.u I_{L2} = (0.5-j0.1) p.u. and I_{21}=(0.25-j0.05) p.u.

26. With the help of a flow chart and equation explain the transient stability analysis using modified Euler's method.
27. Write brief notes on the following:
    (i) Runge- Kutta method for transient stability analysis
    (ii) Representation of synchronous machines from transient stability analysis
    (iii) Representation of tap changing of transformers in load flow studies
    (iv). Fast decoupled load flow analysis.
28. With the help of a flow chart and equation explain the transient stability analysis using Milne's predictor Corrector method.
29. Explain point - point method for transient stability analysis
30. Explain briefly the representation of synchronous machines from transient stability analysis
31. With usual notation, derive the generalized transmission loss formula and B-coefficients.
32. Derive the swing equation with Usual Notation. Draw the swing curve and the same.
33. Explain with necessary equations the solution of swing equation by step by step method.
34. Write short notes on the following:
    a) Limitation of NR method
    b) Solution of Swing Equation using modified Euler Method
    c) Runge- Kutta Method for Transient Stability Analysis.
35. The costs for a plant consisting of 3 units are as follows:
    $F_1=0.1P_1^2+40P_1+100$ Rs/hr
    $F_2=0.125P_2^2+30P_2+30$ Rs/hr
    $F_3=0.15P_3^2+20P_3+150$ Rs/hr
36. Assume that all the 3 units are operating at all times and the total load is 400 MW. The minimum and maximum load as each unit is 20 MW and 150 MW respectively. How will 400 MW be shared among 3 units for optimal generation?
37. In a system with 2 plants, the incremental fuel costs are given by
    $IC_1=0.01\ P_{G1}+20$ Rs/MWhr
    $IC_2=0.015\ P_{G2}+22.5$ Rs/Mwh
    The system is under optimal scheduling with $P_{G1}=P_{G2}=100$ MW. If incremental transmission loss of generator 2 is 0.2 , find the penalty factors and incremental transmission loss of generator 1.
38. What are common assumptions made during the transient studies.
39. Derive the equation for swing equation(curve) considering the rotor dynamics
40. The swing equation of a synchronous generator is $\frac{d\delta}{dx} = \omega - 377\ rad/sec$; $\frac{d\omega}{dx} = 32[1 - 0.4sin\delta]$; At t=0.0sec, ω=377 rad/sec and δ at0.523 radians. Determine the values ω and δat 0.1 secs using Modified Euler method. Assume Δt=0.1 sec.
41. What are numerical methods to solve Swing equation ?
42. What are methods of improving steady state stability ?
43. Mention methods of improving transient stability in power system

PLC & SCADA SEMESTER – VI			
Course Code:	**P21EE6021**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to understand the:

- Block diagram, architecture of PLC and it's working.
- Classify input and output interfacing devices with PLC
- Various Programming languages of PLC with examples and Programming peripherals such as Timers, counter , shift registers
- Architecture of SCADA and the importance of SCADA in critical infrastructure.

UNIT – I	**PLC System**	**10 Hours**

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 component:	List the forms and specifications of PLCs available from various manufacturers

1. **Source material to be referred**: Text Book 1
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study

UNIT – II	Applications of PLC & I/O Processing	**10 Hours**

Combinational Circuits: 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 component:	Examples of Commercial Network systems

1. **Source material to be referred**: Textbook 1.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study

UNIT – III	Programming & Internal Relays	**10 Hours**

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 IR, Master control internal relay

Self-study component:	Programming Examples

1. **Source material to be referred**: Textbook 1
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, Programming Simulation study

UNIT – IV	Timers, Counters & shift registers	**10 Hours**

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 component:	Retentive timer, Timer/counter sequencer	
1. **Source material to be referred**: Textbook 1 2. **Learning Validation method:** Compulsory Unit test 3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.		
UNIT – V	Data handling & SCADA	**10 Hours**
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 component:	case study of a real time SCADA Application	
4. **Source material to be referred**: Textbook 1 & 2. 5. **Learning Validation method:** Compulsory Unit test 6. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities		

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of Engineering to understands basic overview, terminology, I/0, Programming, peripherals & standards of PLC & SCADA	Apply	L1
CO2	Analyze the working of PLC & SCADA Hardwar & Architecture, I/O Device & its Interfacing, Peripherals devices	Analyze	L2
CO3	Devise various PLC Programming techniques to illustrate basic applications	Design	L3
CO4	Execute a project either in simulation or hardware and provide proper documentation	Execute	L4

Text Book(s):

2. W. Bolton, "Programmable Logic Controllers"- 6th edition, Elsevier-newness, 2015
3. Jitender Singh, Monika Deswal, "PLC & SCADA" -Laxmi publication, 2015.

Reference Book(s):

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

Web and Video link(s):

- Introduction to Industrial Automation and Control https://nptel.ac.in/courses/108105063
- https://www.rtautomation.com/technologies/control-iec-61131-3/
- https://accautomation.ca/wiring-push-buttons-and-selector-switch-to-click-plc/

- https://realpars.com/discrete-sensors-part-1/

E-Books/Resources:

- Control of Machines- S.K. Bhattacharya & Brijinder Singh, New Age International Publishers
- Programmable Logic Controllers: John W.Webb, Ronald A.Reis, PHI
- Introduction to PLC by Gary Dunning, Cengage Learning.
- Mechatronics: W.Bolton

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 Engineering to understands basic overview, terminology, I/0, Programming, peripherals & standards of PLC & SCADA	3	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Analyze the working of PLC & SCADA Hardwar & Architecture, I/O Device & its Interfacing, Peripherals devices	2	1	-	-	-	-	-	-	-	-	-	-	-	-
3	Devise various PLC Programming techniques to illustrate basic applications	-	2	3	-	-	-	-	-	-	-	-	-	-	-
4	Execute a project either in simulation or hardware and provide proper documentation	3	3	3	3	3	-	-	-	2	2	2	2	-	-
1-Low		**2-Medium**										**3-High**			

Assignment Questions

1. Prepare a report on how Automation impacts our lives at present.
2. How many bits can a 2K memory store
3. Explain how the on/off operation and direction of a DC motor can be controlled by switches.
4. Explain the use of time relay in Traffic signal control with a circuit diagram
5. Study LIFT Control using PLC a. Explain sequence of operation. b. Draw and explain the Ladder diagram.
6. Study PLC Conveyor Motor Ladder Logic a. Explain sequence of operation 75 b. Draw the relay schematic c. Draw the Ladder diagram d. Explain the type of sensor used to detect the object

7. Study the latest technological changes in this course and present the impact of these changes on overall learning

Review questions

1. Draw a block diagram showing in very general terms the main units in a PLC.
2. Draw a block diagram of a PLC showing the main functional items and how buses link them, explaining the functions of each block.
3. State the characteristics of the relay, transistor and triac types of PLC output channels.
4. How many bits can a 2K memory store?
5. Explain IEC Standard for PLC
6. Explain the operation of the following input devices, stating the form of the signal being sensed and the output: (a) reed switch, (b) incremental shaft encoder, (c) photoelectric transmissive switch, (d) diaphragm pressure switch.
7. Explain how the on−off operation and direction of a d.c. motor can be controlled by switches.
8. Explain the principle of the stepper motor
9. Explain the performance indicators of sensors
10. Explain the purpose of using a parity bit.
11. Explain the continuous updating and the mass input/output copying methods of processing inputs/outputs.
12. Explain PLC operation in processing & updating of data and Scanning time requirements
13. Classify and Explain different types of networks
14. Compare serial and Parallel Communication? List the serial communication standards and Name the connectors used.
15. Explain different types of addressing with examples
16. Illustrate the ladder diagram and functional block diagram for NAND, NOR and XOR logic gates
17. Explain the conventions adopted in drawing ladder diagram
18. Explain the one – shot operation of internal relay with an example.Write ladder and functional block diagram for: output switched off by anyone of four sensors being activatedOutput is on when any one of the input turn's ON
19. Explain procedure used for Sequential function chart
20. Explain Instruction list programming and illustrate
21. Explain structured text programming with example
22. Classify and explain different types of timers
23. Illustrate working of pulse timer.
24. Write timing diagram & ladder diagram for pulse timer when output ceases
25. Construct a ladder diagram which uses the counter to extend the range of a timer.
26. Classify and explain different types of counters
27. Explain the working of 4-bit shift register with ladder diagram
28. Explain the Role of SCADA in Automation of Industries
29. Explain Data movements, comparison instruction of plc with ladder diagram and examples.
30. Explain features and applications of Master terminal Unit and Remote terminal Unit of SCADA

31. Illustrate use of SCADA in following
    a) Electrical power Distribution system
    b) Sewage and water treatment plant
    c) Petroleum industries

Embedded system & IoT SEMESTER – VI			
Course Code:	**P21EE6022**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course aims is to:

- Understand the applications, purpose and design challenges of Embedded System
- Learn about selecting a processor and applications of embedded system in various fields.
- Understand the different types of memories and protocols used in Embedded System
- Learn about design issues and different models used in Embedded System

UNIT – I	**Introduction**	**8 Hours**

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. Embedded system design challenges, common design metrics.
General Purpose Processor: Introduction, Basic Architecture, Operation, Development Environment.
Standard Single-Purpose Processors: Peripherals, Introduction, Timers, Counters, and Watchdog Timers, Timers and Counters, Watchdog Timers, UART, LCD Controllers.

Self-study component:	Microprocessors vs microcontrollers, General-Purpose Processor Design

1**. Source material to be referred**: Textbook 1: 1.1 to 1.6, Textbook 2: 1.1, 1.2, 3.2, 3.3, 3.5, 4.2, 4.3 & 4.5.
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – II	**Memory and Interfacing**	**8 Hours**

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 component:	Arbitration,

1**. Source material to be referred**: Textbook 2: 5.1 to 5.6, 6.1 to 6.5 and 6.9 to 6.11.
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – III	**Hardware Software Co-Design and Interrupts**	**8 Hours**

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.
Interrupts & RTOS: Basics - Shared Data Problem - Interrupt latency. Survey of Software Architecture - Round Robin, Round Robin with Interrupts.

Self-study component:	The UML Tools, Interrupt routines in an RTOS environment

1**. Source material to be referred**: Textbook 1: 7.1 to 7.4. and Textbook 3 : 4.1 to 4.4, 5.1, 5.2
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – IV	**Introduction to IOT**	**8 Hours**

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT **Challenges, Smart Objects:** The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks.
Connecting Smart Objects: Communications Criteria, IoT Access Technologies- Introduction, IEEE802.11ah

Self-study component:	Basic Nodal Capabilities

1**. Source material to be referred**: Textbook 4
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – V	**IOT Applications**	**8 Hours**

Overview, Smart metering /Advanced metering infrastructure, e-health/ Body area networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking.

Self-study component:	Control application examples, Myriad other applications

1**. Source material to be referred**: Textbook 5: 3.1 to 3.8.
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of microcontroller to study the applications and challenges of Embedded System.	Apply	L3
CO2	Examine different types of memories, protocols and design issues involved in Embedded System.	Analyze	L4
CO3	Apply the basic concepts and Frameworks of IOT to realize its applications	Apply	L3
CO4	Design an embedded system for IoT applications.	Create	L5

Text Book(s):

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.

4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
5. "Building the Internet of Things with IPv6 and MIPv6", Daniel Minoli, The Evolving World of M2M Communications, Wiley, 2013 ISBN:9781118473474.

Reference Book(s):

1. Embedded System,- Srinath M S, Gaana H, Shivarudraya Hirematth, Notion Press-2023
2. Embedded Systems: Architecture and Programming, Raj Kamal, TMH.
3. Embedded C programming, Barnett, Cox &O'cull , Thomson (2005).
4. "The Internet of Things", Michael Miller, First Edition, Pearson, 2015. ISBN-13: 978-0- 7897-5400-4, ISBN-10: 0-7897-5400-2

E-Books/Resources:

- https://sushmatoravi.files.wordpress.com/2017/08/233633895-intro-to-embedded-systems-by-shibu-kv.pdf
- http://dsp-book.narod.ru/ESDUA.pdf
- https://download.e-bookshelf.de/download/0000/8067/18/L-G-0000806718-0002366365.pdf

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	PSO2
1	Apply the knowledge of microcontroller to study the applications and challenges of Embedded System.	3	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Examine different types of memories, protocols and design issues involved in Embedded System.	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	Apply the basic concepts and Frameworks of IOT to realize its applications	3		-	-	-	-	-	-	-	-	-	-	-	-
4	Design an embedded system for IOT applications.	3	3	3	2	2	-	-	-	2	2	2	2	-	-
1-Low		**2-Medium**											**3-High**		

Review Questions

1. Classify and explain the embedded system based on generation
2. Give a comparison between Embedded systems and General purpose computing systems
3. Explain the major purpose of embedded systems
4. Explain common design metric of Embedded systems.
5. Explain design technology of Embedded systems.
6. Define Latency and throughput of the embedded system.
7. List out ant four applications of an Embedded systems
8. Derive an equation for percentage revenue loss for the market rise other than 45^0.
9. Determine the percentage of revenue loss of the product life time=30 weeks, delayed entry = 2 weeks
10. Define Cache hit and Cache miss
11. Explain the various events that take place when processor executs an instruction
12. With a neat sketch explain the architecture of General purpose processor.
13. Differentiate between Harvard and Von-Neumann processor/controller architecture
14. Explain design flow and hardware/software tools in developing an embedded systems.
15. Explain UART and watchdog timer
16. Explain ADC
17. Classify and explain various types of Read Only Memory (ROM)
18. Differentiate between SRAM and DRAM
19. Draw the internal structure of a 4x3 ROM
20. What is Cache Mapping Technique? Discuss the different types of mapping technique
21. Draw the internal structure of a 4x3 ROM
22. Draw the internal structure of a 8x3 RAM
23. Define Cache replacement policy
24. Define Hardware/Software Co-design. Explain the fundamental issues in Hardware/software Co-design
25. Discuss the significance of DFG and CDFG model with example
26. Explain concurrent /communicating programming model
27. Explain sequence programming model
28. Design an automatic tea/coffe vending machine based on: (a) Initiated by user inserting a 5 rupee coin (b)The user can select coffe/tea or cancel the order.Draw FSM model for the system.
29. Define HCFSM model.
30. What are the building blocks of UML.
31. Explain the different types of UML buliding blocks and their significance in each stage of the system development life cycle.
32. Explain Round Robin architecture.
33. Explain Round Robin architecture with interrupts.
34. Explain shared data problem with an example
35. Explain semaphore in detail.
36. Explain Messages, mail, queue.
37. Define IoT. Illustrate with an example in detail
38. Explain the IoT Impact

39. Explain the Convergence of IT and IoT
40. Explain different sensors and actuators in IoT
41. Explain IEEE802.11.ah in dtetail
42. Explain a Smart metering /Advanced metering infrastructure sytem
43. Explain a e-health/ Body area networks.
44. Explain a CityAutomation, Automotive Applications of IoT.
45. Explain Home Automation Applications of IoT.
46. Explain Smart Cards, Tracking Applications of IoT

Electrical Machine Design SEMESTER – VI			
Course Code:	**P21EE6023**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Design an electrical machines with the knowledge of material properties
- Design of DC machine
- Design of Single and three phase transformer
- Design of 3-phase Induction motors.
- Design of Synchronous machines.

UNIT – I	**PRINCIPLES OF ELECTRICAL MACHINE DESIGN**	**08 Hours**

Introduction, Considerations for the design of electrical machines, Limitations. Different types of materials used in electrical machines.

Design of Main dimensions of DC 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 component:	**Constructional features of DC machines**

Source material to be referred: Textbook 1- 1.3,2.1,2.6,2.10, 2.12,9.10,9.17
Learning Validation method: Unit test
Pedagogy method used: chalk and talk, Power point presentation.

UNIT – II	**DESIGN OF ARMATURE,YOKE AND WINDINGS OFDC MACHINES**	**08 Hours**

Design of armature slot dimensions, Commutator and Brushes, Design of yoke and pole, Field windings-shunt & series.

Self-study component:	Magnetic circuit- estimation of ampere turns

Source material to be referred: Textbook 1- 9.22, 9.39.4, 9.49-9.53
Learning Validation method: Unit test
Pedagogy method used: chalk and talk, Power point presentation.

UNIT – III	**DESIGN OF TRANSFORMERS**	**08 Hours**

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, Design of tank and cooling tubes

Self-study component:	Methods of cooling of Transformers

Source material to be referred: Textbook 1- 5.1-5.57
Learning Validation method: Unit test
Pedagogy method used: chalk and talk, Power point presentation.

UNIT – IV	**DESIGN OF INDUCTION MOTORS**	**08 Hours**

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 component:	Design of Rotor bars and end rotor	
Source material to be referred: Textbook 1-10.9,10.10-10.20,10.21-10.22.2. **Learning Validation method:** Unit test **Pedagogy method used:** chalk and talk, Power point presentation.		
UNIT – V	**DESIGN OF SYNCHRONOUS MACHINES**	**08 Hours**
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 component:	Design of Turbo alternators	
Source material to be referred: Textbook 1-11.8-11.18, 11.25. **Learning Validation method:** Unit test **Pedagogy method used:** chalk and talk, Power point presentation.		

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply knowledge of material science to study the design of Electrical machines.	Apply	L3
CO2	Analyze the various types of AC and DC Machines.	Analyze	L4
CO3	Design the various types of AC and DC Machines	Analyze	L4
CO4	Evaluate the machine design using modern tools.	Apply	L3

Text Book(s):

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 Book:

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

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	PSO2
1	Apply knowledge of material science to study the design of Electrical machines.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

2	Analyze the various types of AC and DC Machines.	-	3	-	-	-	-	-	-	-	-	-	-	-	2
3	Design the various types of AC and DC Machines	-	-	3	-	-	-	-	-	-	-	-	-	-	2
4	Evaluate assignments using modern tools.	-	-	-	-	3	-	-	-	-	-	-	-	-	2
1-Low				**2-Medium**									**3-High**		

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

Power Quality SEMESTER – VI			
Course Code:	**P21EE6024**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**50**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

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UNIT – I	**INTRODUCTION**	**10 Hours**

Definitions-Power quality, Voltage quality-Power quality issues: Short duration voltage variations, Long duration voltage variations, Transients, Waveform distortion, Voltage imbalance, Voltage fluctuation, Power frequency variations, CBEMA & ITI curves, IEEE and IEC Standards.

Self-study component:	Power quality terms

1. **Source material to be referred**: Textbook 1; 1.1,1.2,2.3-2.9,2.12
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.

UNIT – II	**VOLTAGE SAG & INTERRUPTIONS**	**10 Hours**

Sources of sags and interruptions ; estimating voltage sag performance; fundamental principles of protection, active series compensators, Static transfer switches and fast transfer switches, motor starting sags, Estimation of the sag severity

Self-study component:	Estimating the costs for the sag events

1. **Source material to be referred**: Textbook 1; 3.1-3.3,3.4.3,3.4.10,3.6
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.

UNIT – III	**OVER VOLTAGES**	**10 Hours**

Sources of over voltages - Capacitor switching; lightning & ferro resonance. Devices for protection - surge arresters, suppressors, low pass filters, power conditioners. Lightning protection; shielding & line arresters, scout arrester scheme, An introduction to computer analysis tools for transients, PSCAD and EMTP.

Self-study component:	Transients from load switching

1. **Source material to be referred**: Textbook 1; 4.1,4.1.1,4.1.3,4.1.4-4.3.1,4.3.3,4.3.4,4.5.1,4.5.2,4.5.5, 4.8
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.

UNIT – IV	**HARMONICS**	**10 Hours**

Harmonic distortion, voltage vs current distortion, THD, sources from commercial and industrial loads, locating harmonic sources. Effect of harmonics distortion on capacitors & transformers; inter harmonics. Harmonic distortion evaluation; PCC & utility system, devices for controlling harmonic distortion - passive and active filters. IEEE standards

Self-study component:	IEC standards.

1. **Source material to be referred**: Textbook 1;

5.1,5.2,5.5.1,5.6,5.7,5.8,5.10.1,5.10.2,5.11,6.1.1,6.1.2,6.5

2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.

UNIT – V	**POWER QUALITY MONITORING**	**10 Hours**

Monitoring considerations - monitoring and diagnostic techniques for various power quality problems - modelling of power quality (harmonics and voltage sag) problems by various tools - power line disturbance analyzer – quality measurement equipment - harmonic / spectrum analyzer - flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring.

Self-study component:	Power quality monitoring and the internet

Source material to be referred: Textbook 1; 11.1-11.1.3,11.3-11.3.9, 11.5.2

7. **Learning Validation method:** Unit test
8. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Outline the various power quality problems	L3	Apply
CO2	Discuss the root cause and need of monitoring the power quality problems	L3	Analyze
CO3	Analyze the impact of PQ issues on various electrical components	L4	Analyze
CO4	Inspect a case study on PQ quality issues	L3	Apply

Text Book(s):

1. Roger C.Dugan, Mark F.Mc Granaghan and H.Wayne Beaty, "Electrical Power Systems Quality", McGraw-Hill, NewYork, 3rd Edition 2017.
2. Barry W.Kennedy, "Power Quality Primer", McGraw-Hill, NewYork, 2007

Reference Book(s):

1. Sankaran. C, "Power Quality",CRCPress,Washington, D.C., 2019.
2. Math H.J. Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", IEEE Press, NewYork, 2000.

Web and Video link(s):

- www.nptel.ac.in
- www.electrical4u.com

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	PSO2

1	Apply the knowledge of electrical engineering to study power quality issues.	3	-	-	-	-	-	-	-	-	-	-	-	2	2
2	Analyze the impact of PQ issues on various electrical components	-	3	-	-	-	-	-	-	-	-	-	-	2	2
3	Solve numerical problems on power quality issues	-	3	-	-	-	-	-	-	-	-	-	-	2	2
4	Inspect a case study on PQ quality issues	-	3	-	-	-	-	-	-	2	2	-	2	2	2
1-Low						**2-Medium**							**3-High**		

Assignment Questions

1. What do you understand about power quality issues? Discuss all the power quality issues in brief.
2. Explain the cause and effect with respect to power quality point of view? What is an immunity of the equipment? Discuss the treatment criteria for a machine.
3. Define and technically describe following terms: (1)Linear loads (2)Inrush current (3)Power factor(displacement) (4)Voltage swell (5)Transient
4. What are the power quality standards? Discuss responsibilities of supplier and user of electrical power with respect to power quality
5. Define the following terms 1. Displacement Power Factor 2. Flicker 3. Nonlinear load
6. Explain following terms related to power quality. (1) Grounding (2) Noise (3) Notch.
7. Explain all power quality concerns in brief.
8. What are CBEMA and ITIC graphs? Draw and discuss the ITIC graph in detail
9. Explain different power quality solution techniques in detail.
10. Define the term “Power Quality”. Discuss the common power frequency disturbances with suitable examples.

Mandatory Assessment:

1. A seminar has to be presented on case study for power quality issues/impact/measurement in an electrical system and the report has to be submitted.

Review questions

1. List out the need of power quality standards
2. Comment transients or noise on the power line causingproblems now
3. What are the reasons voltage imbalance
4. Criticize “capacitor switching leads to overvoltage”
5. Distinguish sag and swell

6. What do you mean by power frequency variations in power quality
7. Plot the CBEMA curve
8. Summarize the impact of poor power quality on utility and consumers
9. Discuss some of the solutions for voltage sag and interruption
10 Discriminate on over voltage and under voltage in power quality issue
11 Formulate different categories and characteristics of power quality disturbance in power system network andpoint out which disturbance have most affect the power quality
12 Explain total harmonic distortion and total demand distortion
13 Discuss the standards of power quality
14 Explain the following causes of sag
a)Voltage sag to motor
b) Voltage sag due to single line to line fault
c) Voltage sag due to single line to ground fault
15 Explain various indexes used to estimate voltage sag
16 What is the need for estimating sag performance Explain the different methods of estimating voltage sag Performance
17 Analysis and calculation of power quality due various faulted condition
18 Explain performance voltage sag due to starting of large induction motor in distribution level
How does the load influence on voltage sag adjustable speed drives?
19 Explain the operation of Distribution Static Compensator (DSTATCOM) used for sag mitigation
20 Analyse the different methods for estimating voltage sag severity due to the disturbance in the power system
21 (i) Explain active series compensator to compensate the voltage sag occurs in power system
(ii) Explain how ferro resonance transformer to improve the voltage sag performance
22 (i) Explain the solid state transfer switch with transfer operation
(ii) Explain fast transfer switch with transfer operation
23 What are the various lightning protection scheme used for over voltage protection under the presence of harmonics
24 Briefly explain about shielding and surge arrestor
25 Explain in detail over voltages produced due to Ferro resonance
26 Explain in detail about various methods to mitigate voltage swells
27 Explain in detail about the surge arrestors and surge suppressorsfor over voltage protection.
What are the advantages of surge arrestors? Discuss about the application module
28 What are the devices used for controlling harmonic distortion and explain their function

29 Explain briefly about harmonic distortion and conduct anevaluation of study

30 Explain briefly about the phenomena of how current distortion affects the voltage distortion under the presence of harmonics

31 Explain the function of active filters and how itovercomes the drawbacks of passive filter in controlling harmonic

32 Discuss the effects of harmonics on electrical powercomponents

33 Write short note on the active filter and passive filter in controlling harmonic distortion

34 Explain how commercial and industrial loads areresponsible for harmonic distortion.

35 Discuss the power quality monitoring considerations in details.

36 Explain the flicker meter and flicker measurement techniques in details.

37 Explain in detail with necessary diagram the working principle and functioning of power quality analyzers

38 Briefly discuss the common objectives of power quality monitoring.

39 (i) Bring out the important characteristics of power quality variations.
(i) Explain the steps involved in power quality monitoring. What are the information from monitoring site surveys?

40 (i) Explain the various instruments used for power quality measurements.
(ii) What are the factors to be considered when selecting the instruments?

41 Illustrate the importance of power line analyzer.

42 Explain the features of spectrum analyzer and flicker meters

43 Describe the modelling of power quality problems by mathematical solution tools.

44 Write short note on the following
(i) Disturbance analyzer
(ii) Flicker meter

45 (i) Analyze the role and application of expert systems in power quality monitoring
(ii) Discuss briefly about the different features of harmonic analyzer

46 (i) Explain in detail about the flicker meter
(ii) Design and explain about power quality disturbance analyzer

47 Design the block diagram of advanced power quality monitoring systems. Explain it in detail.

Course Title: Switchgear And Protection SEMESTER VI			
Course Code:	**P21EE6031**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives (CLOs):

This course aims to:

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

UNIT – I	Introduction	8 Hours

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, 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. Related Numerical Problems

Self-study component:	Liquid fuse and its applications

1. **Source material to be referred**: Textbook 1
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.

UNIT – II	Circuit Breakers	8 Hours

Air Circuit breakers – Air break and air blast circuit breakers, **SF_6 breaker** – Properties 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 component:	Rating of Circuit breakers

1. **Source material to be referred**: Textbook 1
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion

UNIT – III	Protective Relaying	8 Hours

Requirement of protective relaying, Zones of protection, Primary and backup protection, Essential qualities of protective relaying, Classification of protective relays		
Self-study component:	Bus bar protection	
1. **Source material to be referred**: Textbook 1 2. **Learning Validation method:** Unit test 3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.		
UNIT – IV	**Types of Relays**	**8 Hours**
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, related Numerical problems		
Self-study component:	Operation of Mho Relay	
UNIT – V	**Protection Schemes**	**8 Hours**
Generator Protection - Merz price protection, prime mover faults, stator and rotor faults; Protection against abnormal conditions – Restricted earth fault protection, Stator Interturn Fault protection, Rotor earth fault protection unbalanced loading, loss of excitation, over speeding. Negative Sequence relay. Related Numerical		
Self-study component:	Bus bar protection	
1. **Source material to be referred**: Textbook 1 2. **Learning Validation method:** Unit test 3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, group discussion.		

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic electrical science to study the operation of various protective devices and protection scheme for electrical machines.	Analyze	L4
CO2	Analyze various protective devices and protection scheme of power system.	Analyze	L4
CO3	Solve numeric problems on protection scheme	Apply	L3
CO4	Study the protective devices and protection scheme employed in Generating station /substation/industries	Analyze	L4

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		**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	PSO2
1	Apply the knowledge of basic electrical science to study the operation of various protective devices and protection scheme for electrical machines.	3	-	-	-	-	-	2	-	-	-	-	2	2	-
2	Analyze various protective devices and protection scheme of power system.	-	3	-	-	-	-	2	-	-	-	2	-	2	-
3	Solve numeric problems on protection scheme	-	3	-	-	-	-	2	-	-	-	2	-	2	-
4	Study the protective devices and protection scheme employed in Generating station /substation/industries	3	3	-	-	-	-	3	1	2	2	-	2	2	-
1-Low					**2-Medium**								**3-High**		

Review Question

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

Renewable Energy Sources SEMESTER – VI			
Course Code:	**P21EE6032**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

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

UNIT – I	**Energy Sources**	**8 Hours**

Introduction: Principles of renewable energy; Importance of energy consumption as measure of prosperity, per capita energy consumption, Classification of energy resources; Conventional energy resources-availability and their limitations, non-conventional energy resources-Classifications, advantage, limitations.

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

Self-study component:	Comparison of conventional and non-conventional energy resources.

1. **Source material to be referred**: 1.1.1, 1.1.2, 1.1.4, 1.1.6, 1.1.8, 1.1.9, 1.1.10, 1.1.11, 1.1.14, 1.2.2, 1.2.3, 1.2.6
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study, activities, group discussion.

UNIT – II	**Solar Energy**	**8 Hours**

Solar Thermal systems: Solar water heater (Flat plate collectors); Solar pond & Concentrating solar collector (Parabolic trough, parabolic dish central collector) still furnaces, green houses.

Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.

Self-study component:	Principle of conversion of solar radiation into heat

1. **Source material to be referred**: 1.3.1,1.3.3, 1.3.8,1.4.3,1.5.6
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study, activities, group discussion.

UNIT – III	**Wind Energy**	**7 Hours**

Wind Energy: Introduction, Wind site selection consideration, Basic Components of a WECS, Classifications of WECS, Derivation of power in the wind, electrical power output & capacity factor of WECS, Advantages &

Disadvantages of WECS		
Self-study component:	Wind & its property	

1. **Source material to be referred**: 1.6.1, 1.6.2, 1.6.4, 1.6.5, 1.6.6, 1.6.7, 1.6.8
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study, activities, group discussion.

UNIT – IV	**Biomass Energy**	**8 Hours**

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

Self-study component:	Photosynthesis process

1. **Source material to be referred**: 1.7.1, 1.7.2, 1.7.1,1.7.5, 1.7.9, 1.7.10
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study, activities, group discussion.

UNIT – V	**Energy From Ocean**	**9 Hours**

Energy From Ocean: Components of tidal power plant (TPP), Classification of tidal power plant, Estimation of energy-single Basin & Double Basin type TTP(no derivation, simple numerical problems), Advantages & Limitation of TTP. Ocean thermal Energy Conversion(OTEC) - methods of OTEC power generation-open cycle(Claude Cycle),closed cycle(Anderson cycle) &Hybrid cycle(Block diagram description only).

Self-study component:	Introduction to Grid integration **,** Principle of Tidal power.

1. **Source material to be referred**: 1.9.1, 1.9.2, 1.9.3
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, case study, activities, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**
CO1	Apply the knowledge of basic science regarding non conventional energy sources.	Remember
CO2	Analyze the various non conventional energy sources.	Understand
CO3	Analyze real-world case studies related to renewable energy sources.	Apply
CO4	Evaluate non conventional energy systems using numerical methods.	Analyze

Text Book(s):

1. Rai,GD,Non-conventional sources of energy,4th Edition,Khanna publishers, New Delhi,2007.
2. Khan B H,Non-conventional energy resources,TMH, New Delhi,2006.

Reference Book(s):

1. Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018
2.Mukherjee D & ChakrabortiS,Fundamentals of Renewable Energy Systems, New Age International Publishers,2005.

Web and Video link(s): (e-Resources):

- https://onlinecourses.nptel.ac.in/noc18_ge09/preview

E-Books/Resources:

- E-book URL: https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html
- E-book URL:https://www.pdfdrive.com/non-conventional-energy-systems-npteld17376903.html
- E-book URL: https://www.pdfdrive.com/renewable-energy-sources-and-their-applications33423592.html
- E-book URL: https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sourcese34339149.html

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	PSO2
1	Apply the knowledge of basic science regarding non conventional energy sources.	3	-	-	-	-	-	2	-	-	-	-	2	2	-
2	Analyze the various non conventional energy sources.	-	3	-	-	-	-	2	-	-	-	2	-	2	-
3	Analyze real-world case studies related to renewable energy sources.	-	3	-	-	-	-	2	-	-	-	2	-	2	-
4	Evaluate non conventional energy systems using numerical methods.	3	3	-	-	-	-	-	-	-	-	-	-	2	-
1-Low		**2-Medium**												**3-High**	

Review questions

1. What are primary and secondary energy sources?
2. What are the conventional and non-conventional energy sources?
3. Explain per capita energy consumption.
4. Discuss briefly the possibilities of utilizing the following methods of power

generation:
   a. Solar energy
   b. Magneto hydrodynamics
   c. Fuel cells.
5. Write short notes on:
   a. Wind energy
   b. Tidal energy
   c. Bio-mass and bio-gas
   d. OTEC
6. What are the prospects of non-conventional energy sources in India? Explain.
7. What is meant by renewable energy sources?
8. What are the advantages of renewable energy sources?
9. What are the limitations of renewable energy sources?
10. Explain the principle of conversion of solar energy into heat.
11. What are the main components of a flat-plate solar collector, explain the function of each?
12. How solar air collectors are classified?
13. What are the main applications of a solar drier?
14. Enumerate the different types of concnetrating type collectors.
15. Enumerate the different applications of solar energy.
16. With a neat diagram explain the box type solar cooker.
17. With the help of a neat sketch describe a solar air heating collector system.
18. What are the main components of a flat plate collector.
19. What are the advantages and disadvantages of concentrating collectors over a flat-plate collectors?
20. What is the principle of solar photovoltaic power generation?
21. What are the main elements of a PV system?
22. With a diagram explain the Grid integrated solar PV System.
23. What are the advantages and disadvantages of photovoltaic solar energy conversion?
24. Describe the principle of working of solar furnace. What are its main applications?
25. What are the advantages and limitations of a solar furnace?
26. What do you mean by a green house?
27. Enumerate the main types of green houses.
28. What is the basic principle of wind energy conversion?
29. Derive the expression for power developed due to wind.
30. Describe the main considerations in selecting a site for wind generators.
31. Describe with a neat sketch the working of a wind energy system (WECS) with main components.
32. How are WEC systems classified? Discuss in brief.
33. Discuss the advantages and disadvantages of wind energy conversion system?
34. Describe the main applications of wind energy system.
35. What is biomass ?
36. Write a note on the classification of Biomass Resources.

37. List the factors that affects biodigestion.
38. Explian the following terms with respect to Biomass conversion Process.
    i. Fermentation
    ii. Anaerobic digestion
    iii. Thermal Conversion
39. With a diagram explain the KVIC Model of Biogas plant.
40. With a diagram explain the Janatha Model of Biogas plant.
41. Write a note on Biomass Programs in India.
42. Explain the different schemes used to generate power from Tidal Power Plant.
43. Write a brief description on different components of Tidal Power Plant?
44. What are the difficulties in tidal power developments?
45. What is the basic principle of ocean thermal energy conversion?
46. Explain the open cycle OTEC system with a neat diagram.
47. Describe the 'closed cycle' OTEC system with a neat diagram.
48. Enumerate the advantages of Closed cycle OTEC system over 'open cycle' OTEC system.
49. Write a note on Hybrid Cycle of OTEC System.

DSP Processor and Applications SEMESTER – VI			
Course Code:	**P21EE6033**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course aims is to:

- Provide the understanding of architecture, programming and interfacing of commercially available Digital Signal Processor.
- Discuss the effective use of Digital Signal Processor in system implementation.
- Adopt the MATLAB tools in DSP applications.
- Provide the understanding of architecture features of TMS320C54XX.
- Understand the interfacing procedure to use programmable Digital Signal Processor.

UNIT – I	**Architectures for Programmable DSP Devices**	**8 Hours**

Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing.

Self-study component:	Explain pipelining and parallel processing with real life example. Also comment on time requirement in each process.

1**. Source material to be referred**: Textbook 1: 4.1 to 4.10.
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – II	**Fixed Point Digital Signal Processors**	**8 Hours**

Introduction, Commercial Digital Signal– processing Devices, Data Addressing Modes of TMS32OC54xx DSPs, Memory Space of TMS32OC54xx Processors, Program Control, TMS32OC54xx Instructions and programming, On–chip Peripherals, Interrupts of TMS32OC54xx Processors.

Self-study component:	Study memory (internal and extended), peripherals and general purpose I/O pins characteristics of 54X processors.

1**. Source material to be referred**: Textbook 1: 5.1 to 5.9
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – III	**DSP Algorithms**	**8 Hours**

Introduction, the Q– notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID controller, Adaptive Filters, 2–D Signal Processing, FFT Algorithm for DFT Computation

Self-study component:	Point FFT Implementation on the TMS32OC54xx

1**. Source material to be referred**: Textbook 1: 7.1 to 7.9 and 8.2
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point pre1entation, case study.

UNIT – IV	**I/O Peripherals to Programmable DSP Devices**	**8 Hours**

Introduction, Memory Space Organization, External Bus Interfacing Signals, Memory Interface,

Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA).	
Self-study component:	Study of Multi-channel Buffered Serial Port.

1**. Source material to be referred**: Textbook 1: 9.1 o 9.8.
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – V	**Interfacing and Applications of DSP Processor**	**8 Hours**

Interfacing and Applications of DSP Processor: Introduction, Synchronous Serial Interface, A Multichannel Buffered Serial Port (McBSP), A CODEC Interface Circuit.

Applications of DSP Devices : Introduction, DC-DC buck-boost converters: Converter Structure, Continuous Conduction Mode, Connecting the DSP to the Buck-Boost Converter , Controlling the Buck-Boost Converter-flow diagrams, A Position control system for a hard disk drive, DSP based Power meter.

Self-study component:	Implement speech processing system using MATLAB.

1**. Source material to be referred**: Textbook 1: 10.2, 10.3 & 10.5 and 11.1. 11.6& 11.7. Textbook 2: 7.1 to 7.3, 7.5, 7.6
2**. Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the basic digital circuit knowledge to study the DSP Processor.	Apply	L3
CO2	Analyze the architecture features of Digital signal processor.	Analyze	L4
CO3	Apply the logical and signal processing concepts to develop algorithms for DSP processor.	Apply	L3
CO4	Design the interfacing of memory and signal converters.	Create	L5

Text Book(s):

1. "Digital Signal Processing", Avatar Singh and S. Srinivasan, Thomson Learning, 1st edition 2004. ISBN 10: 0534391230 / ISBN 13: 9780534391232.
2. Hamid Toliyat and Steven Campbell, "DSP-Based Elect romechanical Motion Control", CRC Press, 2011.

Reference Book(s):

1. "Modern Digital Signal Processing", V. Udayashankara, Eastern Economy Edition, 2016. ISBN 10: 8120345673 / ISBN 13: 9788120345676.
2. "Digital Signal Processors Architectures, Implementations, and Applications" Sen M Kuo, Woon-seng Gan , Pearson Edition, 2005. ISBN-13: 978-0130352149, ISBN-10: 0130352144.
3. "Digital Signal Processors- Architecture, Programming and Applications" B Venkataramani, M

Bhaskar, McGraw Hill Education, 2015. ISBN-10: 9780070702561.

Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the basic digital circuit knowledge to study the DSP Processor.	-	3	-	-	-	-	-	-	-	-	-	-	-	-
2	Analyze the architecture features of Digital signal processor.	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	Apply the logical and signal processing concepts to develop algorithms for DSP processor.	3	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Design the interfacing of memory and signal converters.	2	2	2	2	2	-	-	-	2	2	-	2	-	-
1-Low		**2-Medium**											**3-High**		

Review Questions

1. Give a comparison between DSP processor and general purpose processor.
2. Explain thew structure of 4x4 Barun multiplier.
3. Explain the MAC unit.
4. Explain the bus architecture and logic unit of DSP processor.
5. Explain the different addressing modes of DSP processor.
6. Explain the speed issues of DSP processor.
7. Explain the architecture of Texas InstrumentsTMS320C25 digital signal processor.
8. Explain the functional architecture of TMS320C54xx digital signal processor.

9. Explain the functional diagram of central processing unit of TMS320C54xx digital signal processor.
10. Explain the functional diagram of barrel shifter of TMS320C54xx digital signal processor.
11. Explain the different addressing modes of TMS320C54xx digital signal processor.
12. Explain the memory space of TMS320C54xx digital signal processor.
13. Explain the on-chip peripherals of TMS320C54xx digital signal processor.
14. Explain the interrupts of TMS320C54xx digital signal processor.
15. Explain the Q-notation of DSP.
16. Explain the interpolation filters.
17. Explain the concept of decimation filters.
18. Explain the feedback mechanism of PID controller.
19. What is adaptive filter? Explain in detail
20. Explain the concept of 2-D signal processing.
21. Explain the time sequence for external memory access.
22. Explain wait states of TMS320C54xx digital signal processor with timing diagram
23. With a neat sketch explain the I/O interface signals for a read –write-read sequence of operation.
24. Explain the Interrupts of TMS320C54xx digital signal processor.
25. Explain the register sub addresing technique for configuring DMS operation.
26. With a neat sketch explain a multichannel buffered serial port.
27. Explain buck boost converter in detail.
28. Explain the flow diagram for Controlling the Buck-Boost Converter.
29. Explain continuous conduction mode of buck boost converter in detail
30. Explain a position control system for a hard disk drive.

Flexible AC Transmission Systems SEMESTER – VI			
Course Code:	**P21EE6034**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Concepts and general system configuration of FACTS devices
- Basic concepts of Single-phase full-wave bridge converter and its operation
- Basic concepts, 3-phase full wave current and voltage rectifier
- Static Shunt Compensator: SVC,STATCOM
- Static Series Compensators: GCSC,TSSC,TCSC and SSSC

UNIT – I	**FACTS Concepts**	**08 Hours**

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

Self-study component:	Conversation of Basic Gates into Universal

1. **Source material to be referred**: 1.1 to 1.7Indicated Textbook1, Chapter 1
2. **Learning validation method:** Compulsory Unit Test
3. **Pedagogy method used:** Chalk and Talk, Power Point Presentation, Smart Board, MATLAB Simulation Results.

UNIT – II	**Voltage Sourced Converters**	**08 Hours**

Basic concepts, single phase full wave bridge converter operation, square wave voltage harmonics for a single-phase bridge 3 phase full wave bridge converter, transformed connections for 12, 24 and 48 pulse operation, three level VSC and PWM converter.

Self-study component:	Generalized technique of harmonics elimination and voltage control

1. **Source material to be referred**: 3.1 to 3.10 Indicated Textbook 1, Chapter 3
2. **Learning validation method:** Compulsory Unit Test
3. **Pedagogy method used:** Chalk and Talk, Power Point Presentation, Smart Board, MATLAB Simulation Results.

UNIT – III	**Self and Line Commutated Current Source Converter**	**08 Hours**

Basic concepts, 3-phase full wave diode rectifier, Thyristor based converter with gate turn on but without gate turn off, Current sourced converter with turn-off devices current stiff converter, Current source versus voltage source converters.

Self-study component:	AC and DC Current Harmonics

1. **Source material to be referred**: 4.1 to 4.5 Indicated Textbook 1, Chapter 4
2. **Learning validation method:** Compulsory Unit Test
3. **Pedagogy method used:** Chalk and Talk, Power Point Presentation, Smart Board, MATLAB Simulation Results.

UNIT – IV	**Static Shunt Compensator**	**08 Hours**

Objective of shunt compensation includes midpoint, end of line voltage, improvement of transient stability and POD, methods of controllable Var generation, static Var compensator, SVC and STATCOM, comparison between SVC and STATCOM.

Self-study component:	Static Var Systems

1. **Source material to be referred**: 5.1 to 5.4 Indicated Textbook 1, Chapter 5
2. **Learning validation method:** Compulsory Unit Test
3. **Pedagogy method used:** Chalk and Talk, Power Point Presentation, Smart Board, MATLAB Simulation Results.

UNIT – V	**Static Series Compensators:**	**08 Hours**

Objectives of series compensation includes voltage, transient stability, POD and sub synchronous oscillation damping, variable impedance type of series compensation, switching converter type series compensation,

Self-study component:	External Control for Series Reactive Compensators

1. **Source material to be referred**: 6.1 to 6.3 Indicated Textbook 1, Chapter 6
2. **Learning validation method:**Compulsory Unit Test
3. **Pedagogy method used:** Chalk and Talk, Power Point Presentation, Smart Board, MATLAB Simulation Results.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the basic concepts of transmission interconnections of FACTS technology.	Remember	L1
CO2	Analyze the current and voltage sourced converters benefits of FACTS devices.	Analyze	L4
CO3	Analyze the shunt and series controllers in the transmission system.	Analyze	L4
CO4	Analyze the shunt and series device connected devices in the transmission system using MATLAB Simulink.	Analyze	L4

Text book(s):

1.narain g. hingorani and laszlogyugyi, understanding facts: concepts and technology of flexible ac transmission systems, IEEE press, standard publisher's distributors, Delhi, 1st edition, 2001.
2.k. r. padiyar, FACTS controllersin power transmissionand distribution, New Age International (P) Limited, Publishers,Delhi,1st edition.2007.

Reference Book(s):

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

Web and Video link(s):

- NPTEL Videos: https://onlinecourses.nptel.ac.in/noc23_ee58/student/home

E-Books/Resources:

- https://books.google.co.in/books/about/Understanding_FACTS.html?id=2-ceAQAAIAAJ&redir_esc=y

- https://research.iaun.ac.ir/pd/bahador.fani/pdfs/UploadFile_8100.pdf

Course Assessment Matrix (CAM)

Course Outcome (CO)	Program Outcome													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12	PSO1	PSO2
Apply the basic concepts of transmission interconnections of FACTS technology.	3	3	1	-	-	2	-	-	-	-	-	2	3	2
Analyze the current and voltage sourced converters benefits of FACTS devices.	2	3	3	-	-	2	-	-	-	-	-	2	2	2
Analyze the shunt and series controllers in the transmission system.	2	3	3	-	-	2	-	-	-	-	-	2	2	2
Analyze the shunt and series device connected devices in the transmission system using MATLAB Simulink.	2	3	3	-	-	2	-	-	-	-	-	2	2	2
1 – Low, 2 – Moderate and 3 – High														

Assignment Questions:

1. In general, how FACTS controllers are categorized? Briefly explain each one of them.
2. Discuss the basic principles of voltage sourced converters and its concept with the help of relevant circuits.
3. Derive the expression for the fundamental and harmonics of square wave output voltage of a single-phase bridge converter. Prove that the RMS value of the fundamental component V1=0.9Vd.
4. Write about current – sourced converters versus voltage – sourced converters with respect to their advantages and disadvantages.

5. Briefly explain the V-I characteristics of (TSSC) thyristor switched series capacitor when operated in voltage control and reactance control modes.
6. Explain Static Var Compensators, SVC and STATCOM with respect to V – I and V- Q characteristics and loss versus VAR output characteristics.
7. Explain with the help of waveforms of basic operating control schemes for GCSC and TCSC.
8. Explain the concepts of series capacitive compensation for a two-machine power system along with its phasor diagram and power angle characteristics.

Review Questions:

1. With relevant diagrams, explain the AC power flow in parallel paths and in a meshed system.
2. Explain the basic types of FACTS controller along with its symbolic notations.

3. With relevant diagrams, explain the AC power flow in parallel paths and in a meshed system.

4. Explain basic types Shunt and Series types of FACTS controller along with its symbolic notations.

5. Explain how FACTS plays vital role in flow of power in an AC system, considering both the

Cases of parallel paths and meshed system with neat sketches.

6. In general, how FACTS controllers are categorized? Briefly explain each one of them.

7. List out the possible benefits from FACTS technology.

8. What is transmission Interconnections? Why we need transmission Interconnection?

9. Mention the Basic types of FACTS controllers and explain any two.

10. With the help of phasor diagrams, explain the power flow and dynamic stability considerations of a transmission interconnection of a two-machine system.

11. Write the basic concept of voltage sourced converter.

12. Derive the expression for the fundamental and harmonics of square wave output voltage of a single-phase bridge converter. Prove that the RMS value of the fundamental component V1=0.9Vd.

13. Briefly explain the single-phase full wave bridge voltage sourced converter operation along with its circuit diagram and waveforms.

14. Discuss the basic principles of voltage sourced converters and its concept with the help of relevant circuits.

15. Explain the single-phase full wave bridge converter operation.

16. Explain the operation of three-phase full wave voltage sourced converter, with relevant circuit diagram and waveforms.

17. With the help of a circuit diagram and waveforms, explain the single-phase full wave bridge converter operation.

18. Explain the single phase full wave bridge voltage sourced converter operation.

19. Explain basic concept of voltage sourced converter.

20. Explain the 3 phase full wave diode rectifier operation including commutation angle.

21. Explain the three principal types of current sourced converter.

22. With the help of neat sketches, explain the three principal types of current sourced converters.

23. Discuss three – phase, full – wave six pulse diode converter in detail neglecting commutation angle, showing relevant current and voltage waveforms.

24. Explain the three-phase, full wave diode rectifier neglecting commutation angle.

25. Explain current stiff converters with relevant circuit diagram and waveform.

26. Compare current sourced converter versus voltage sourced converter.

27. Explain Thyristor based converter operation of Valve voltage.

28. Explain the operation of AC Harmonics.

29. Explain the operation of DC Harmonics.

30. Difference between the current sourced converter versus voltage sourced converter.

31. Explain the current sourced converter with turn– of devices.

32. Write about current – sourced converters versus voltage – sourced converters with respect to their advantages and disadvantages.

33. Why we need transmission interconnections? Enumerate its relative importance.

34. Explain the three principal types of current sourced converter.

35. Write a note on current sourced converter versus voltage sourced converter.

36. Enumerate the relative importance of controllable parameters.

37. Briefly explain the loss versus Var output characteristics of different static Var generator schemes.

38. Explain the concepts of series capacitive compensation for a 2 machine power system along with its phasor diagram and power angle characteristics.

39. Briefly explain the V-I characteristics of (TSSC) thyristor switched series capacitor when operated in voltage control and reactance control modes.

40. Series compensation helps to improve transient stability and effectively damps the power oscillations. Justify the above statement.

41. Explain the concept of series capacitive compensation for a two- machine power system.

42. With the help of basic circuit arrangement, explain the operation of Thyristors Controlled Series Capacitor. (T.C.S.C).

43. Discuss in detail GCSC with the help of Basic GTO controlled series capacitor circuit.

44. With the help of block diagram obtain waveforms of basic operating control schemes for GCSC, TSSC, and TCSC.

45. With the help of block diagram, explain the functional system (external) control scheme for

the SSSC.

46. Enumerate the differences in characteristics and features of different series compensators.

47. Explain STATIC Var Compensators, SVC and STATCOM with respect to V – I and V- Q characteristics and loss versus VAR output characteristics.

48. Summarize the basic characteristics of main static Var generators in the form of table.

49. Explain single Phase full wave phase relationship between current and voltage.

50. Explain with the help of waveforms of basic operating control schemes for GCSC and TCSC.

Control Systems SEMESTER – VI			
Course Code:	**P21EE604**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**50**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

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

UNIT – I	**Mathematical Modeling of Systems:**	**08 Hours**

Fundamental Concepts of Control Systems: Basic definitions of control systems, Classification, Open loop and Closed loop systems with examples, 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).

Self-study component:	Effects of feedback on overall gain.

1. **Source material to be referred**: 1.1.1-1.1.4,1.2.1-1.2.5,1.3.1-1.3.2,1.4.1-1.4.4, 2.1.1-2.2.7
2. **Learning Validation method:** Unit test
3. **Pedagogy method used:** chalk and talk, smart board.

Practical Topics:	a. Draw the speed – torque characteristic of a two - phase A.C. servomotor b. Draw the speed – torque characteristic of a D.C. servomotor.

UNIT – II	**Transient and Steady State Analyses**	**08 Hours**

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.

Self-study component:	Ramp and impulse response of second order system.

1. **Source material to be referred**: 1.7.1-1.7.6, 1.7.8.
2. **Learning Validation method**: Unit test
3. **Pedagogy method used:** chalk and talk, smart board.

Practical Topics:	c. Determine time domain specifications using MATLab d. Determine steady state error using MATLab

UNIT – III	**Stability analysis in time domain**	**08 Hours**

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, effect of addition of poles and zeros on stability.

Self-study component:	Relative stability analysis

1. **Source material to be referred**: 1.6.1-1.6.5,1.8.1-1.8.4,2.6.1-2.7.3
2. **Learning Validation method**: Unit test
3. **Pedagogy method used:** chalk and talk, smart board.

Practical Topics:	e. Draw the root-locus for a given TF using MATLab f. Determine angle of departure, point of intersection with imaginary axis, K_{margin} for a system using MATLab

UNIT – IV	**Frequency-Response Analysis**	**08 Hours**

Frequency-Response Analysis: correlation between time response and frequency response, frequency response specifications- resonant peak, resonant frequency and bandwidth.

Graphical Analysis of Frequency –Response:

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.

Self-study component:	Polar plot.

1. **Source material to be referred**: 1.9.1-1.9.2,1.9.11-1.9.12
2. **Learning Validation method**: Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

Practical Topics:	g. Draw Bodeplot for given open loop TF using MATLab h. Determine Phase margin, gain margin using MATLab

UNIT – V	Nyquist Plot and Design of controllers, compensators	08 Hours

Pole-zero configurations, concept of encirclement, analytical function and singularities, mapping theorem, Nyquist stability criteria, and determination of stability from the Nyquist plot(Transfer function limited to two zeros and two poles)
Design of controllers: Introduction to P, PI and PID controllers. Design of controllers to improve transient and steady state response.
Design of compensators: Design of lag compensators, lead compensators and lag-lead compensators.

Self-study component:	Advantages and disadvantages of P, PI and PID Controllers.

1. **Source material to be referred**:1.9.5,2.9.1-2.9.4,1.10.1-1.10.7
2. **Learning Validation method**: Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board.

Practical Topics:	i. Study the effect of P, PI, PD and PID controller. j. Study the Compensating networks viz., Lag, Lead and Lag- lead compensating networks.

Course Outcomes: On completion of this course, students are able to

Cos	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of electrical engineering to study the basics of linear systems.	Apply	L3
CO2	Apply the knowledge of mathematics to develop model to determine the various parameters of control system.	Apply	L3
CO3	Analyze the stability of a system in time domain and frequency domain.	Analyze	L4
CO4	Design of controllers and compensators.	Create	L6
CO5	Apply the theoretical knowledge to conduct the experiment and execute the programs in MATLAB.	Analyze	L4

Text Books:

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

Reference Book(s):

1. Katsuhiko Ogata, "Modern Control Engineering", PHI Learning Private Limited, 5th edition, 2011

Source material to be referred

- First digit indicates textbook number, second digit indicates chapter number, third digit indicates chapter number

Web and Video link(s):

https://youtu.be/XMfH2P2Fc6Q

https://youtu.be/HcLYoCmWOjI

E-Books/Resources:

- https://amzn.eu/d/5iMNKSN
- https://controltheorymaster.files.wordpress.com/2017/11/farid-golnaraghi-benjamin-c-kuo-automatic-control-systems.pdf

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	PSO1	PSO2
1	Apply the knowledge of electrical engineering to study the basics of linear systems	-	3	-	-	-	-	-	-	-	-	-	-	-	-
2	Apply the knowledge of mathematics to develop model to determine the various parameters of control system.	-	3	-	-	-	-	-	-	-	-	-	-	-	-
3	Analyze the stability of a system in time domain and frequency domain.	3	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Design of controllers and compensators.	-	-	3	-	-	-	-	-	-	-	-	-	-	-
5	Apply the theoretical knowledge to conduct the experiment and execute the programs in MATLAB.	2	2	2	2	2	-	-	-	2	2	-	2	-	-
1-Low		**2-Medium**											**3-High**		

Review questions

1. Define (i) System (ii) Control System
2. Define and differentiate open loop and closed loop system by giving suitable examples
3. Define the Transfer function of a system.
4. Explain the significance of a transfer function stating its advantages and features
5. 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
6. What is transfer function modeling of Control systems?
7. Derive the transfer function modeling of (i) Electrical (ii) Mechanical (iii) Electromechanical systems.
8. Explain the derivation of analogues networks using (i) Force Voltage (ii) force Current analogy.
9. Derive the analogous electrical networks based on (i) Force Voltage (ii) force Current analogy for different mechanical systems.

10. Derive the transfer function for field control and armature controlled DC motor.
11. Define time response (transient response and steady state response) of a control system.
12. Explain the Impulse, step and ramp response of first order systems.
13. Explain how the damping ratio affects the time response of a second order system?
14. 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
15. With a neat sketch explain all time domain specifications?
16. 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.
17. Determine the time domain specifications for second order systems
18. Explain how steady state error of control system is determined
19. Derive the expression for static error coefficients for different systems
20. Explain the effect of adding poles and zeros to open loop and closed loop transfer Function
21. Define the following terms (i) stable system (ii) unstable system (iii) critically stable system (iv)Conditionally stable system
22. Explain the concepts of asymptotic stability, impulse response stability, BIBO stability.
23. Explain the R-H Criteria.
24. Determine the stability of a system for different characteristic equation and determine the range of K for stability.
25. Determine K marginal and nature of roots for given characteristic equation.
26. What is root-locus? Explain with suitable examples.
27. Explain the rules for sketching root-locus for different order systems
28. Explain how to determine the transient performance specifications and the value of K for specified ξ
29. Explain the impact of adding poles and zeros to the product of G(s)H(s) on the shape of the Root locus.
30. How to determine gain margin from the root locus?
31. What is frequency domain analysis?
32. Write a note on co-relation between time domain and frequency domain
33. Define and derive the expression for bandwidth of a second order system
34. Derive the expressions for resonant frequency ω_r for the second order system in terms of ξ and ω_n.
35. Derive the expressions for resonant frequency ω_r for the second order system in terms of ξ and ω_n.
36. Derive the frequency domain specifications for different systems.
37. What are Bode plots? State the advantages of Bode plots.
38. Explain the nature of Bode plots for (i) Poles at origin (ii) simple pole (iii) simple zero
39. Explain the concept of gain margin and phase margin. Explain how these values help in studying relative stability
40. Determine the value of K for different Gain margin and Phase Margin.
41. Derive the transfer function from the Bode magnitude plot.
42. Design a P-Controller to improve transient stability.
43. Design a PI-Controller to improve transient stability.
44. Design a PID-Controller to improve transient stability.
45. Design a P-Controller to improve steady state stability.
46. Design a PI-Controller to improve steady state stability.
47. Design a PID-Controller to improve steady state stability.
48. Design a lag compensation circuit.

49. Design a lead compensation circuit.
50. Design a lag-lead compensation circuit.

Utilization of Electrical Power SEMESTER – VI			
Course Code:	**P21EEO6051**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the different types of heating and welding.
- Understand the different Lighting scheme and types of lamps.
- To study about Electric traction.
- To get the knowledge of speed-time characteristics of Electric train.
- To study the different traction motors and their applications

UNIT – I	**Electric Heating and Welding**	**08 Hours**

Introduction, mode of heat transfer, advantages and methods of electric heating, resistance heating, arc heating, induction heating, Dielectric heating, Electric welding and their types.

Self-study component:	

1. **Source material to be referred**: 1 indicated Textbook 1, Chapter 2, Concept 2.1 to 2.2
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – II	**Illumination**	**08Hours**

Introduction, Definitions, Laws of illumination, Lighting schemes, Design of lighting scheme, construction and working of Incandescent, sodium vapour lamp, mercury vapour lamp, fluorescent lamp, CFL and LED light bulb.

Self-study component:	street lighting, factory lighting, Flood lighting

1. **Source material to be referred**:1 indicated Textbook 1, Chapter 1,Concept 1.1,1.2,1.3,1.7,1.9,1.10
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – III	**Systems of Electric Traction**	**08 Hours**

Introduction, requirement of an ideal traction system, System of traction, various types of electric traction, electric trains, tramways, trolley buses, systems of electrification for traction purposes, Methods of supplying power to Railway trains, Applications of systems for Railway electrifications.

Self-study component:	Diesel electric traction

1. **Source material to be referred**: 2 indicated Textbook 2, Chapter 46, Concept 1 to 9.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – IV	Speed-Time Characteristics	08 Hours

Analysis of speed-time curve for electric train, Important Terms used in traction, Simplified Speed-Time curves, tractive effort for propulsion of train, specific energy output, various factors affecting energy consumption.

Self-study component:	Types of railway systems

1. **Source material to be referred**:1 indicated Textbook 1,Chapter7,Concept 7.1,7.2,7.3,7.4,7.6,7.7,7.8.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – V	Traction Motors	08 Hours

Introduction, selection of traction motors, DC Motor, AC series motor, Three Phase Induction Motor, Methods of speed control - energy saving by series-parallel method, electric braking- plugging, rheostatic braking, regenerative breaking.

Self-study component:	linear induction motor and their use

1. **Source material to be referred**: 1 indicated Reference Book 1, Chapter 4, Concept 4.9, 4.10, 4.13.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic physics to study the utilization of electrical power.	Understand	L2
CO2	Analyze the different electric traction system.	analyze	L4
CO3	Solve numerical problems on electrical power utilization	analyze	L4
CO4	Evaluate effective lighting schemes for various applications	evaluate	L5

Text Book(s):

1. Er.R. K Rajput "UTILIZATION OF ELECTRICAL POWER" ,Laxmi publication (P) Ltd, 2nd edition 2018.
2. Dr. S.L. Uppal, Prof. S Rao "ELECTRICAL POWER SYSTEMS", Khanna Publishers,15th edition, 2011
3. A.Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar, "Power system Engineering", Dhanpat Rai& Co., 2010.

Reference Book(s):

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

Web and Video link(s):

- https://www.youtube.com/watch?v=jn9ouzQl37k
- https://www.youtube.com/watch?v=VqDIh356104
- https://www.youtube.com/watch?v=zMaO8rcEhdI
- https://www.youtube.com/watch?v=PW44aMos2YA
- https://www.youtube.com/watch?v=ekOBzHGV9XE
- https://www.youtube.com/watch?v=ingbs2FzsTA

E-Books/Resources:

- https://easyengineering.net/utilisation-of-electrical-power-by-rajput/
- https://www.bookslock.org/utilization-of-electrical-energy-textbook-pdf-eee-books/
- https://book.jobscaptain.com/utilisation-of-electrical-power/

Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of physics to study the utilization of electrical power .	3	-	-	-	-	-	-	-	-	-	-	1	-	-
2	Analyze the different electric traction	-	3	-	-	-	-	-	-	-	-	-	1	-	-
3	Solve numerical problems on electrical power utilization	-	3	-	-	-	-	-	-	-	-	-	-	-	-
4	Evaluate effective lighting scheme for various applications	-	-	3	-	-	-	-	-	-	-	-	-	-	-
1-Low		**2-Medium**											**3-High**		

Assignment Questions

1. What are the advantages of electrically produced heat? Describe the constructional features of a resistance oven. What properties the element must possess?

2. A 40-kW, 3-phase, 400-volt resistance oven is to employ Ni-Cr strip of 0.3 mm thickness. The heating elements are star connected. If the wire temperature is to be 1127°C and that of charge is to be 727°C, estimate the suitable width and length of the wire required. Radiation efficiency = 0.6, specific resistance of Ni-Cr = 1.03x 10 ohm-m. Emissivity =0.9. What would be the temperature of the wire when the charge is cold?

3. Distinguish between the direct and indirect type of arc furnaces. State their field of application.

4. Estimate the rating of an induction furnace to melt two tonnes of zinc in one hour if it operates at an efficiency of 70%. Specific heat of zinc is equal to 0.1, Latent heat of fusion of zinc 26.67 k-cal per kg. Melting point is 455°C. Assume the initial temperature to be 25°C.

5. Describe the construction and working of an induction furnace suitable for melting and refining of non-ferrous metals.

6. A 50-kW, 3-phase, 400-V resistance oven is star-connected. Heating element used is nickel-chrome strip 0.25 mm thick. If the wire temperature is to be 1,000°C and that of the charge is to be 727°C, estimate a suitable width and length of the wire required. Take emissivity = 0.9, radiating efficiency = 0.6, specific resistance of nickel-chrome = 1.03 ×10b ohm-m.

7. Discuss the principle of arc welding and the difference between carbon and metallic arc welding and their relative merits.

8. An indoor badminton court is accommodated in a hall 20 metres long, 10 metres wide and 15 metres high. The walls and ceiling of the hail are painted black and do not reflect, any light. Design a scheme for providing an average illumination of 80 lux at ground surface, using 200 W tungsten filament lamps with suitable fittings. Give reasons for your choice. Coefficient of utilization = 0.5.Efficiency of lamp = 15 lumens per watt.

9. With the help of circuit diagrams, explain the working of the following light sources :

(a) High pressure mercury vapour lamps (b) Fluorescent tube (c) Carbon arc lamp .What are the usual values of power factors for the above lamps?

10. Give a detailed account of fluorescent lamps of various types. How is the stroboscopic effect minimized? What are their advantages and disadvantages as compared to other light sources?

11. What are the polar curves as applied to light sources? Show how these curves are used for finding out mean horizontal candle power and mean spherical candle power.

12. Explain the the terms: (i) Adhesive weight, and (ii) Train resistance.

A locomotive accelerates a 400-tonne train up a gradient of 1 in 100 at 0.8 km phps. Assuming the coefficient of adhesion to be 0.25, determine the minimum adhesive weight of the locomotive. Assume train resistance of 60 N per tonne and allow 10% for the effect of rotational inertia.

13. An electric train while going down an incline of 1 in 200 has the following speed-time curve : (i) Starting from rest a uniform acceleration of 2 km phps for 30 sec. (ii) Steady speed for 40 seconds (with mechanical braking), (ii) Coasting for 50 seconds and (iv) Braking at rate of 3 km phps. Assume the track resistance as 45 N per tonne, allowance for rotational inertia 10%, overall effi ciency 70%, and calculate the specific energy consumption.

14. What are the typical values of acceleration and braking retardation in electric traction ? How is the value of acceleration or retardation calculated from the data of a typical speed-time curve ?

15. Deduce expressions for:

(i) the tractive effort exerted by the road wheel in terms of wheel diameter, motor torque gear ratio and the efficiency of transmission of power through gears;

(ii) The tractive effort for propulsion of a train on level track;

(iii) The tractive effort for propulsion of a train up and down a gradient;

Review questions

1. What are the advantages of electric heating?

2. Give classification of various electric heating methods along with brief account of their working principle.

3. Explain briefly the following modes of heat transfer :

(i) conduction,

(ii) Convection,

(iii) Radiation.

4. List the properties of a good heating element.

5. Explain briefly the materials of heating elements.

6. Discuss the methods of temperature control of resistance ovens.

7. Explain the design procedure of the heating elements when the power and voltage of the oven is known.

8. Explain the working principle of arc furnaces and describe with the help of a sketch the construction and working of any one type of arc furnace.

9. Describe the construction and working of a 3-phase arc furnace.

10. Describe the conditions for maximum output for an electric arc furnace.

11. Mention the advantages of dielectric heating.

12. Discuss the relative merits and demerits of direct and indirect electric arc furnaces.

13. Explain different methods of induction heating. Give some applications of induction heating.

14. What is the basic nature of light ? Explain.

15. Define the following terms :

Luminous flux, Lumen, Illumination, Lamp efficiency & Explain briefly the following:

(i) Space-height ratio

(ii) Utilization factor

(iii) Depreciation factor.

16. What is a solid angle?

17. State the laws of illumination.

18. Enumerate the various types of electric lamps in common use.

19. Explain briefly the materials commonly used for incandescent lamps.

20. Explain with a neat sketch, the construction and working of a sodium vapour lamp.

21. Give the construction and working of a 'fluorescent tube'.

22. Explain briefly the various types of lighting systems.

23. Enumerate the characteristics which the lighting scheme should possess.

24. Revive expressions for illumination on a surface (i) when it is normal and (it) when it is inclined to the axis of a beam of incident light.

25. What is a polar curve? How is it useful to an illumination engineer?

26. What do you understand by polar curves? Explain Rousseau's construction for calculating m.s.c.p. of a lamp.

27. Why is tungsten selected as the filament material and on what factors does its life depend ?

28. Prove that in a filament lamp the diameter of filament is directly proportional to r, where I is the current flowing in the filament.

29. Explain the advantages of using inert gas in filament lamps and the purpose to get the filament as coiled coil.

30. Describe the metal filament lamps high lighting the effect of temperature and the choice of filament materials.

31. Explain the effects of voltage variation on the life and illumination as regards tungsten lamp and fluorescent lamp.

32. Compare the metal filament lamp with discharge lamp.

33. Compare the metal filament lamp with discharge lamp. What is the advantage of coiled coil? Describe principle of operation, construction and working of a sodium discharge lamp.

34. State the significant fentures of traction drives.

35. Discuss briefly the desirable properties of traction motors.

36. What are the chief requirements of a traction motor with regards to electrical and mechanical features ?

37. Give the essential electrical and mechanical characteristics of traction motora.

38. State the mechanical and electrical features of electric traction motors and discuss the relative suitability of (i) D.C. series motor, (li) A.C. series motor.

39. Enumerate the motors which commonly find application in traction.

40. State the advantages of squirrel-cage induction motor over D.C. motors.

41. What is the major disadvantage of a D.C. motor?

42. Discuss the suitability of series motors for traction duties with the help of characteristic curves.

43. Discuss in detail why series motors are ideal for D.C. or A.C. traction.

44. What is the effect of changing wheel diameter and gear ratio on the characteristics of a motor?

45. State the effects of wheels that are worn out when used along with new wheels to drive a train.

46. What speed-torque characteristics are desirable for traction motors operating (i) suburban services (it) main line service?

47. Explain how the difference in driving wheel diameters due to unequal wear affects the sharing of load by two similar series motors, working in parallel, driving an electric train.

48. What type of A.C. motor is usually employed for single-phase electric traction? Discuss briefly the principal features in the construction of the motor and analytically how good commutation and high power factor are obtained. For what frequency and voltage are such motors usually built and why?

49. Explain briefly the construction and characteristics of A.C. series motor, pointing out how they differ from the D.C. type. In what way is the good commutation and high power factor assured ?

50. Discuss with neat sketches the construction and working principle of high acceleration linear induction motor. Discuss its advantages and disadvantages.

51. State the merits and demerits of the induction motor for traction duties.

52. Discuss the advantages of series-parallel starting against the ordinary rheostatic starting for a pair of D.C. traction motors.

Hybrid Electric Vehicles **SEMESTER – SIX**			
Course Code:	**P21EEO6052**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**0-2-0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Explain the electric, hybrid and plug on hybrid vehicle their architecture ,technologies and fundamentals
- Explain the concepts of power electronics converters
- Explain the various motors used in Electric vehicle.
- Discuss different energy storage technologies used for hybrid electric vehicles and their control Explain the different configurations of electric vehicles and charging techniques.

UNIT – I	**Introduction &Plug-in Hybrid Electric Vehicles**	**08 Hours**

Sustainable Transportation, A Brief History of HEVs, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs. vehicle architectures: Series Hybrid Vehicle, Parallel Hybrid Vehicle.
Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs

Self-study component:	Other Topics on PHEVs

1. **Source material to be referred**: 1.1.6-1.1.7-1.5.1-1.5.2-indicated Textbook 1., Chapter 1, Concept 1 in chapter 1.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – II	**Power Electronics in HEVs**	**08Hours**

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

Self-study component:	HEV to PHEV Conversions

1. **Source material to be referred**: 1.6.1-1.6.2 indicated Textbook 1., Chapter 6, Concept 1 in chapter 2.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation

UNIT – III	**Electric Machines and Drives in HEVs**	**08 Hours**

Introduction, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Modeling of Traction Motors.

Self-study component:	

1. **Source material to be referred**: 1.6.2-1.6.3-1.6.4 indicated Textbook 1., Chapter 6, Concept 2
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, Power point presentation

UNIT – IV	**Batteries, Ultra capacitors, Fuel Cells, and Controls**	**08 Hours**

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, Hydraulic Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System.

5 Hrs

Self-study component:	Flywheel Energy Storage System

1. **Source material to be referred**: 1.10.1-1.10.2-1.12.1-1.12.2 indicated Textbook 1., Chapter 10, Concept 1 in chapter 1.
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, smart board

UNIT – V	**EV charging Technologies**	**08 Hours**

Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle ,Vehicle to Building, bidirectional EV charging Systems, energy management strategies used in hybrid and electric vehicle.

Self-study component:	Wireless power transfer technique for EV charging.

1. **Source material to be referred**: 2.14.1-2.14.2-2.14.3 indicated Textbook 2, Chapter 14, and Concept 1
2. **Learning Validation method:** Compulsory Unit test
3. **Pedagogy method used:** chalk and talk, smart board

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic science to study components	Applying	L3

	of HEV's		
CO2	Construct the architecture and power technologies of Plug-in EVs	Applying	L3
CO3	Analyse the various concepts of machines & power converters used in PHEV's	Analyze	L4
CO4	Examine the types of batteries used in PHEVs &the control and configurations of Hybrid Electric Vehicle charging stations	Analyze	L4

Text Books:

1. Mehrdad Ehasni,yimiGao,Sebestian E.Gay,Ali Emadi,Modern Electric ,Hybrid Electric and Fuel Cell vehicles:Fundamentals,Theory and Design,CRC press ,2004
2. Chris Mi, M.Abul Masrur,David Wenzhong Gao, Hybrid Electricvehicles: Principles and Applications with practical perpectives,John wiley&sons Ltd,2011

Reference Books:

1. James Larminie,John Lowry,Electric vehicle Technology Explained;wiley ,2003
2. Iqbal Hussein ,Electric vehicles :Design fundamentals ,CRC press 2003

Web and Video link(s):

- https://www.youtube.com/watch?v=h5ysddrlXLw
- https://www.youtube.com/watch?v=qxmhFRx2fOw
- https://www.youtube.com/watch?v=9mO-WUB3KVQ
- https://www.youtube.com/watch?v=6H5vtu5_SF4
- https://www.youtube.com/watch?v=cyEj90LM1SQ

E-Books/Resources:

- https://books.google.co.in/books/about/Electric_Hybrid_Vehicles.html?id=kVkJzgEACAAJ&redir_esc=y
- https://books.google.co.in/books/about/Hybrid_Electric_Vehicles.html?id=IdPZ3NYhF68C&redir_esc=y
- https://books.google.co.in/books/about/Hybrid_Electric_Vehicles.html?id=IdPZ3NYhF68C&redir_esc=y

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	-	-	-	-	-	-	-	-	-	-	-	-	2

2	Construct the architecture and power technologies of Plug-in EVs	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	Analyse the various concepts of machines & power converters used in PHEV's	-	3	-	-	-	-	-	-	-	-	-	-	-	2
4	Examine the types of batteries used in PHEVs &the control and configurations of Hybrid Electric Vehicle charging stations	-	3	-	-	-	-	-	-	-	-	-	-	-	2
1-Low				**2-Medium**									**3-High**		

Review questions

1. Discuss the history of hybrid electric vehicles.
2. With a neat sketch, explain the configuration of Series hybrid electric drive train.
3. Dissect the environmental importance of EV and their social impacts.
4. Explain the different power flow control modes of a typical parallel hybrid system with the help of block diagrams.
5. Explain the two-quadrant operation of chopper DC motor drive with suitable waveforms for electric vehicle
6. What are factors affecting the performance of batteries used in EVs?
7. What are different modes of charging batteries? Compare them in detail
8. Explain fuel cell and flywheel as energy source elements in electric and hybrid electric vehicle
9. With the help of a neat block diagram explain different subsystems of electric drive train.
10. Explain the different power flow control modes of a typical parallel hybrid system with the help of block diagrams.
11. Comment on the suitability of DC and AC machines for electric and hybrid electric vehicle applications.
12. What are different modes of charging batteries? Compare them in detail.
13. Explain historical background of EV and HEV technology involvement
14. Enlist the different architectures of hybrid electric drive train and explain the series hybrid electric drive train
15. Explain fuel cell and flywheel as energy source elements in electric and hybrid electric vehicle

Energy Auditing & Demand Side Management SEMESTER – VI			
Course Code:	**P21EEO6053**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to understand,

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

UNIT – I	**Introduction to Energy Sources & Energy Economic Analysis**	**8 Hours**

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

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

Self-study component:	Taxes and tax-credit

1. **Source material to be referred**: 1.1.0-1.1.4,1.1.9,1.1.12-1.1.18,1.2.1-1.2.7,1.5.21-1.5.27
2. **Learning Validation method:** Topic Seminar.
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – II	**Energy Auditing**	**8 Hours**

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

Self-study component:	Electrical System Optimization

1. **Source material to be referred**: 1.3.1-1.3.13
2. **Learning Validation method:** Topic Seminar.
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – III	**Electrical Equipment and power factor correction**	**8 Hours**

Power factor improvement-Power factor, causes of low power factor, advantages of high power factor, disadvantages of low power factor, Power factor improvement equipment-static capacitors, synchronous condenser, and phase advancers. Calculation of power factor correction, importance of power factor improvement, most economical power factor, location & sizing of capacitors, energy efficient motors, Numerical on power factor correction.

Self-study component:	Lighting basics

1. **Source material to be referred**: 1.5.1-1.5.15
2. **Learning Validation method:** Topic Seminar.
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – IV	**Demand Side Management**	**8 Hours**

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

Self-study component:	Energy efficient technology in electrical system.

1. **Source material to be referred**: 1.6.1-1.6.4
2. **Learning Validation method:** Topic Seminar.
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

UNIT – V	**Load management**	**8 Hours**

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

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

1. **Source material to be referred**: 1.6.4-1.6.12
2. **Learning Validation method:** Topic Seminar.
3. **Pedagogy method used:** chalk and talk, Power point presentation, smart board, case study, activities, group discussion.

Course Outcomes: On completion of this course, students are able to

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	Describe the Energy situation, Time value of money concept & ABT, Energy Auditing, Energy Use Profiles and Energy Audit Instruments.	Understanding	L2
CO2	Apply the knowledge of mathematics & electrical laws to solve problems related to energy auditing & DSM.	Applying	L3
CO3	Analyze the concept of electrical distribution codes & standards, Demand Side Management along with its benefits. Also different techniques of DSM, DSM implementation issues & strategies and organization of energy conservation programs.	Analyzing	L4
CO4	Case studies on concept of pay back analysis, depreciation, location & sizing of capacitors and energy efficient motors.	Analyzing	L4

Text Book(s):

1. " Energy Auditing and Demand Side Management" –N. G. Ajjanna, Gouthami Publications, 1st edition, 2012
2. "Fundamentals of Energy Engineering" - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey.
3. Electrical distribution – Pabla, TMH Publishers, 2004.

Reference Book(s):

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

E-Books/Resources:

- https://www.scribd.com/document/309248556/Eee-Viii-Energy-Auditing-Demand-Side-Management-10ee842-Notes
- https://vemu.org/uploads/lecture_notes/03_01_2020_1480276911.pdf

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	PS O1	PS O2

1	Describe the Energy situation, Time value of money concept & ABT, Energy Auditing, Energy Use Profiles and Energy Audit Instruments.	3	-	-	-	-	2	1	-	-	-	-	2	2	-
2	Apply the knowledge of mathematics & electrical laws to solve problems related to energy auditing & DSM.	3	-	-	-	-	2	2	-	-	-	-	2	2	-
3	Analyze the concept of electrical distribution codes & standards, Demand Side Management along with its benefits. Also different techniques of DSM, DSM implementation issues & strategies and organization of energy conservation programs.	-	3	-	-	-	2	2	-	-	-	-	2	2	1
4	Case studies on concept of pay back analysis, depreciation, location & sizing of capacitors and energy efficient motors.	-	3	-	-	-	2	2	-	-	-	-	2	2	1
1-Low					**2-Medium**									**3-High**	

Review questions

1. Explain Energy Situation in world and India elaborately.
2. Define load profiles.
3. Define the term energy audit briefly explain various types of energy auditing.
4. Explain in brief about electrical energy consumption and conservation in India& in world.
5. Explain about the energy conservation schemes.
6. Write short notes on standard & legislation.
7. What is P.F? Explain its methods for improving power factors.
8. Explain about the importance of energy efficient motors.
9. Explain about factors affecting the efficiency of motors.
10. What are the limitations of low P.F.
11. Explain concept of energy audit? Types of energy audit.
12. Explain the energy conservation schemes.
13. Explain brief about electrical energy consumption and conservation in India and world.
14. Explain the representation of energy forms? Explain their Significance in energy audit with suitable example.

15. Explain about codes and standards.
16. What is meant by the term 'energy audit' and what are its objectives?
17. Explain about energy conservation schemes.
18. Define Energy audit.
19. Explain types of energy audit.
20. Discuss about energy conservation methods.
21. Explain the factors affecting of energy efficient motors.
22. Explain power factor improvement methods.
23. What Are Energy Efficient Motors (EEMS).What factor affecting the energy efficient motors?
24. Discuss how capacitors can be employed for improvement of power factor of an electrical system.
25. Explain about the location of capacitors for power factor improvement.
26. Explain the difference between energy efficient motors and standard motors.
27. Define power factor.
28. Explain about Energy Instruments Thermocouple.
29. Explain about Energy Instruments- Lux meter & Thermocouple.
30. Explain about Energy Instruments- Pyrometers.
31. Explain about Good lighting system design and practice.
32. What is meant by demand side management and list out its benefits?
33. Discuss about multi-utility power exchange model in detail.
34. Define DSM and explain the benefits of DSM.
35. Explain about the concept of 'time of day pricing'.
36. Explain in detail about the different techniques of DSM with necessary examples.
37. Explain detail about Load priority technique & strategic conservation.
38. Define load management and explain its importance.
39. Discuss in brief about peak clipping and peak shifting.
40. Explain briefly about Energy efficient equipments.
41. What is load management? Explain its importance.
42. Write short notes on load priority techniques.
43. Write short notes on strategic conservation.
44. Explain the significance of load management in detail.
45. Explain concept and features of DSM.
46. Write short notes on (i) valley filling (ii) load shifting (iii) strategic load growth.
47. Define DSM. Write benefits of DSM.
48. Define load management.
49. Discuss about valley filling & peak clipping.
50. Explain in detail about (a) pay back analysis (b) Depreciation 3. (a)Explain the methods available for determining the annual rate.

Course Title: Testing and commissioning of Electrical Equipments SEMESTER VI			
Course Code:	**P21EEO6054**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives : This course will enable the students to,

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

UNIT – I	**Introduction**	**8 Hours**

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

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

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

Self-study component:	Different types of transformer oil tanks

UNIT – II	**SYNCHRONOUS MACHINES**	**8 Hours**

Specifications: As per BIS standards.

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

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

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

Self-study component:	Selection of motor

UNIT – III	**INDUCTION MOTORS**	**8 Hours**

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

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

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

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

Self-study component:	Maintenance of induction motor

UNIT – IV	**SWITCH GEAR & PROTECTIVE DEVICES**	**8 Hours**

Standards, types, specification, installation, commissioning tests, maintenance schedule, type & routine tests.

Current transformer and Voltage transformer: Specifications, procurement , testing of CT, Specifications, procurement , testing of PT, Specifications and testing of cable

Self-study component:	Rating of circuit breaker

UNIT – V	**Safety Management**	**8 Hours**

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

Self-study component:	First aid its importance

Course Outcomes: On completion of this course, students are able to

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Apply the knowledge of basic electrical science to study the operation of various Electrical equipments	Analyze	L4
CO2	Analyze the installation procedure of electrical equipments	Analyze	L4
CO3	Analyze the different testing & commissioning procedure of electrical equipments	Apply	L3
CO4	Study the installation & commissioning test employed at various Generating station /substation/industries	Analyze	L4

TEXT BOOKS:

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

Publication.

REFERENCE BOOKS:

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

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	PS O1	PS O2
1	Apply the knowledge of basic electrical science to study the operation of various Electrical equipments	3	-	-	-	-	-	2	-	-	-	-	2	2	-
2	Analyze the installation procedure of electrical equipments	-	3	-	-	-	-	2	-	-	-	2	-	2	-
3	Analyze the different testing & commissioning procedure of electrical equipments	-	3	-	-	-	-	2	-	-	-	2	-	2	-
4	Study the installation & commissioning test employed at various Generating station /substation/industries	3	3	-	-	-	-	3	1	2	2	-	2	2	-
1-Low		**2-Medium**												**3-High**	

Review Questions :

1. What are the standard specifications of a power transformer
2. What is drying out of transformer . Explain different methods of drying out
3. Explain the various accessories of power transformer
4. State the various commissioning test on power transformer
5. Explain the operation of Bucholz relay
6. Explain the specifications of 3 phase distribution transformer
7. Explain phasor diagram for 3 phase transformer
8. Discuss he different types of transformer tank
9. Explain clearly testing of transformer oil
10. Ex plain polarity test
11. What is Plorarisation Index
12. Explain no current and no load losses

13. Explain temperature rise test
14. Explain the classification of insulating material
15. Explain different methods cooling of transformer
16. Explain test setup for impulse testing of power transformer
17. Explain partial discharge test and di electric test
18. Explain power frequency withstand test and sudden short circuit withstand test
19. What are the cause and troubles and failure in power transformer
20. Write a note on maintenance of transformer
21. Explain the qualities of good insulating oil
22. What is tan delta test ? explain
23. Explain the specifications of synchronous machine
24. Explain the various cooling methods adopted for synchronous machine
25. State and explain the various test on synchronous machine and their significance
26. Explain slip test conducted on synchronous machine
27. Explain the procedure of measuring dc resistance of armature winding of a synchronous machine.
28. Explain the open circuit test on synchronous machine
29. What is short circuit ratio and explain how it is obtained.
30. Explain the foundation details for installing induction motor
31. Explain the procedures of conducting vibration test on induction motor
32. Write a brief note on shaft alignment of induction motor
33. Explain static and dynamic balancing of rotor of induction motor
34. Explain the specification of three phase induction motors
35. Explain how no load and blocked rotor test are used to determine the efficiency of a induction motor
36. Explain blocked rotor test on induction motor
37. How rotor balancing is done
38. Explain high voltage test on induction motor
39. Explain the procedure of H V test on induction motor
40. Explain the method of measuring insulation resistance of the windings in induction motors . What are the factors that affects this measurement
41. What are the methods to provide rotor earth fault protection
42. Explain the procedure of installation of circuit breaker and metal clad switch gear
43. What are different type test conducted on circuit breaker ?. explain
44. Explain the various steps in maintenance of circuit breaker
45. State and Explain various test performed on high voltage a.c. circuit breaker
46. Explain different test conducted on CT and PT
47. Explain different test conducted on cables
48. State the seven principles of safety management
49. Explain the procedure of work permit at site
50. Recommend safety precautions against electrical shock in small building, shops and Lv stations.
51. Explain the safety management interface with O and M

52. State and explain the principles of live line working

Power System Simulation Lab SEMESTER – VI			
Course Code:	**P21EEL606**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0:0:2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**18**	**SEE Marks:**	**50**

This course aims

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

Sl. No	List of Experiments	No. of .Hours
1.	**C**alculation of ABCD parameters for medium and long transmission line systems. Verification of AD-BC=1. Determination of efficiency and regulation.	**2**
2.	(i)Y-Bus formation for power systems by inspection method. (ii) Determination of bus currents, bus power and line flows for a specified system with given bus voltage profile.	**2**
3.	Bus admittance matrix (Y – Bus) formation for power systems with and without mutual Coupling, by singular transformation.	**2**
4.	To determine fault currents and voltages in a single transmission line system with a Specified location for SLG fault, LL fault, and LLG fault.	**2**
5.	Determination of power angle diagram of salient and non-salient pole synchronous machines. Calculation of reluctance power & regulation.	**2**
6.	Load flow analysis using (i) Gauss Siedel method, (ii) Newton Raphson method, and (iii) Fast decoupled flow method for both PQ and PV buses using software package.	**2**
7.	Determination of optimal generator scheduling for thermal plants.	**2**
8.	To determine I) Swing curve II) Critical clearing time for a single machine connected to Infinite bus through a pair of identical transmission lines.	**2**
9.	Self-Study experiment viz. Analysis of typical power system (problems) by using software package or MATLAB programs.	**2**

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	PS O1	PS O2
1	Apply the knowledge of power systems for formation of Y bus with and without mutual coupling using MATLAB Programming	3	3	-	-	3	-	-	-	-	-	-	-	2	-
2	Conduct experiments to execute programs to study load flow, different faults and stability of the power system.	3	3	-	-	3	-	-	-	-	-	-	-	-	2
3	Ability to communicate effectively in a team/as an individual s to conduct experiments	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1-Low		**2-Medium**											**3-High**		

EMPLOYABILITY ENHANCEMENT SKILLS - VI [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI for CSE, ISE, ECE, EEE & CSE(AIML) Branches only			
Course Code:	**P21HSMC608B**	**Credits:**	**01**
Teaching Hours/Week (L:T:P)	**0:2:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**30**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Calculations involving permutations and combinations, probability, ages and data interpretation.
- Explain concepts behind logical reasoning modules of syllogisms and data sufficiency.
- Prepare students for Job recruitment process and competitive exams.
- Develop problem solving skills through various programming language.

UNIT – I		**06 Hours**

Quantitative Aptitude: Permutation and Combination, Probability, Ages.

Self-study component:	Inferred meaning

UNIT – II		**06 Hours**

Quantitative Aptitude: Interpretation.

Logical Reasoning: Syllogisms, Data Sufficiency.

Self-study component:	Chain rule

UNIT – III		**06 Hours**

Soft skills: Group Discussions, Resume Writing, LinkedIn Profiling, Interview Skills.

Interview Preparation: Mock GDs, Resume Validation and Personal Interviews.

Self-study component:	Interpersonal communication

UNIT – IV	**COMPETITIVE CODING - I**	**06 Hours**

Arrays: Find a peak element which is not smaller than its neighbors,K^{th} Smallest largest element, Kadane's Algorithm, Missing number in array, Rearrange Array Alternately, Sort 0s, 1s and 2s, Trapping Rain Water, Chocolate Distribution Problem, Array Leaders, Minimum Number of Platforms Required for a Railway/Bus Station,Rotate a matrix by 90 degree without using any extra space, Find maximum element of each row in a matrix, Print matrix in snake pattern.

Strings: Reverse words in a given string, Converting Roman Numerals to Integer, Find the minimum distance between the given two words, Check whether two Strings are anagram of each other,

Remove duplicates from a given string, Multiply Strings, Find largest word in dictionary, Longest Common Prefix, Reduce the string by removing K consecutive identical characters, Check if given String is Pangram or not, Compare Version Numbers.

Self-study component:	Logarithmic Complexity with Binary Search

UNIT – V	**COMPETITIVE CODING - II**	**06 Hours**

Linked List: Print the Middle of a given linked list, Reverse a Linked List, Reverse a Doubly Linked List, Rotate a Linked List, Delete middle of linked list, Pairwise Swap Nodes of a given Linked List, Remove duplicates from a sorted linked list, Convert singly linked list into circular linked list, Merge two sorted linked lists, check if a singly linked list is palindrome, Insert a node in the 5^{th} position in a singly linked list.

Stacks and Queues: Parenthesis Checker, Reverse a String using Stack, Reverse an array using Stack, Delete Middle element from stack, Find Next Greater Element using Stack, The Stock Span Problem, Reverse First k Elements of Queue, insert one element at front using queue, Implement a Queue using an Array, Maximum number of diamonds that can be gained in K minutes,Sorting a Queue without extra space.

Database: Introduction to database, Types of SQL statements, MySQL commands.

Self-study component:	Schema change statements in SQL.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	Solve the problems based on Permutation and combination, Probability, ages and data interpretation.	Applying	L3
CO2	Solve logical reasoning problems based on Syllogisms and Data Sufficiency.	Applying	L3
CO3	Apply suitable programming language and / or suitable data structures to solve the given problem.	Applying	L3

Text Book(s):

1. Guide to Competitive Programming: Learning and Improving Algorithms Through Contests by Antti Laaksonen
2. Cracking the Coding Interview by Gayle Laakmann McDowell
3. Fundamentals of Database Systems – Elmasri and Navathe, 6th Edition, Addison-Wesley, 2011.
4. Quantitative aptitude by Dr. R. S Agarwal, published by S. Chand private limited.

5. How to sharpen your interview skills by Prem Vas

Reference Book(s):

1. E. Balaguruswamy, Programming in ANSI C, 7th Edition, Tata McGraw-Hill. Brian W. Kernighan and Dennis M. Ritchie, The 'C' Programming Language, Prentice Hall of India.
2. Data Base System Concepts – Silberschatz, Korth and Sudharshan, 5th Edition, Mc-Graw Hill, 2006
3. An Introduction to Database Systems – C.J. Date, A. Kannan, S. Swamynatham, 8th Edition, Pearson Education, 2006.
4. Quantitative Aptitude by Arun Sharma, McGraw Hill Education Pvt Ltd.

Web and Video link(s):

1. Problem Solving through Programming in C - https://archive.nptel.ac.in/courses/106/105/106105171/
2. https://onlinecourses.nptel.ac.in/noc22_cs91/
3. https://youtu.be/c5HAwKX-suM
4. https://onlinecourses.nptel.ac.in/noc18_cs15/preview
5. http://nptel.ac.in/courses/106106093/
6. http://nptel.ac.in/courses/106106095/

COURSE ARTICULATION MATRIX
(EMPLOYABILITY ENHANCEMENT SKILLS - VI– P22HSMC608B)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	1

Universal Human Values and Professional Ethics [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P21UHV609**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**1: 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**25 + 5**	**SEE Marks:**	**50**

Course objectives:

This course is intended to:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4. This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied skills.
3. State the need for UHV activities and its present relevance in the society and Provide real-life examples.
4. Support and guide the students for self-study activities.
5. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
6. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous selfevolution.
7. Encourage the students for group work to improve their creative and analytical skills.

Module - 1

Introduction to Value Education **(3 hours)**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity –

Current Scenario, Method to Fulfil the Basic Human Aspirations

Module - 2

Harmony in the Human Being : (3 hours)
Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health

Module - 3

Harmony in the Family and Society : (3 hours)
Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order

Module - 4

Harmony in the Nature/Existence : (3 hours)
Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

Module - 5

Implications of the Holistic Understanding – a Look at Professional Ethics : (3 hours)
Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession

Course outcome (Course Skill Set)
At the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature);

- They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
- They would have better critical ability.
- They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
- It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Expected to positively impact common graduate attributes like:
1. Ethical human conduct

2. Socially responsible behaviour
3. Holistic vision of life
4. Environmentally responsible work
5. Having Competence and Capabilities for Maintaining Health and Hygiene
6. Appreciation and aspiration for excellence (merit) and gratitude for all

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.
- CIE paper shall be set for 25 questions, each of the 02 marks. The pattern of the question paper is MCQ (multiple choice question). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

The sum of two tests, will be out of 100 marks and will be scaled down to 50 marks
Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for **50 questions,** each of the 01 marks. **The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books for READING:

Text Book and Teachers Manual

- The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
- The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
16. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.
19. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.
20. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow.Reprinted 2008.

Web links and Video Lectures (e-Resources):

Value Education websites,

- https://www.uhv.org.in/uhv-ii,
- http://uhv.ac.in,
- http://www.uptu.ac.in
- Story of Stuff,
- http://www.storyofstuff.com
- Al Gore, An Inconvenient Truth, Paramount Classics, USA
- Charlie Chaplin, Modern Times, United Artists, USA
- IIT Delhi, Modern Technology – the Untold Story
- Gandhi A., Right Here Right Now, Cyclewala Productions
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- https://fdp-si.aicte-india.org/8dayUHV_download.php
- https://www.youtube.com/watch?v=8ovkLRYXIjE
- https://www.youtube.com/watch?v=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM