SYLLABUS

(With effect from 2024 -25)

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(□□□□□□□□ □□□□ 2024-25)

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.

	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	P22EE501	Strategic Management And Electrical Estimation	E&EE	3	-	-	-	3	50	50	100
2	P22EE502	Power System analysis and Stability	E&EE	3	-	-	-	3	50	50	100
3	P22EE503X	**Professional Elective Course-I**	E&EE	3	-	-	-	3	50	50	100
4	P22EE504	Power Electronics (Integrated)	E&EE	3	-	2	-	4	50	50	100
5	P22EE505	Solar PV Systems	E&EE	3	-	-	-	3	50	50	100
6	P22EEL506	Computer Aided Electrical Drawing	E&EE	-	-	2	-	1	50	50	100
7	P22INT507	Internship–II	E&EE	-	-	-	-	2	50	50	100
8	P22HSMC508B	Employability Enhancement Skills–V	HSMC	1	-	-	-	1	50	50	100
9.	P22UHV509	Social Connect and Responsibility	E&EE	1	-	-	-	1	50	50	100
	Total							**21**			

Professional Elective Course – I (P22EE503X)	
Course Code	**Course Code**
P22EE5031	Utilization of Electrical Power
P22EE5032	Measurement & Instrumentation
P22EE5033	Special Electrical Machines
P22EE5034	Data communication and Networking

	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	P22EE601	Computer Techniques in Power Systems	E&EE	3	-	-	-	3	50	50	100
2	P22EE602X	**Professional Elective Course – II**	E&EE	3	-	-	-	3	50	50	100
3	P22EE603X	**Professional Elective Course – III**	E&EE	3	-	-	-	3	50	50	100
4	P22EE604	Control System (Integrated)	E&EE	3	-	2	-	4	50	50	100
5	P22EEO605X	**Open Elective–I**	E&EE	3	-	-	-	3	50	50	100
6	P22EEL606	Power System Simulation Lab	E&EE	-	-	2	-	1	50	50	100
7	P22EEMP607	Mini–Project	E&EE	-	-	2	2	2	50	50	100
8	P22HSMC608B	Employability Enhancement Skills–VI	HSMC	1	-	-	-	1	50	50	100
9.	P22UHV609	Universal Human Values and Professional Ethics	E&EE	1	-	-	-	1	50	50	100
	Total							**21**			

Professional Elective Course – II (P22EE602X)	
Course Code	**Course Code**
P22EE6021	PLC and SCADA
P22EE6022	Renewable Energy Sources
P22EE6023	Electrical Machine Design
P22EE6024	Power Quality

Professional Elective Course – III (P22EE603X)	
Course Code	**Course Code**
P22EE6031	Switchgear and Protection
P22EE6032	Embedded system & IOT
P22EE6033	DSP Prosessor and Applications
P22EE6034	Flexible AC Transmission Systems

Open Elective – I(P22EEO605X)	
Course Code	**Course Code**
P22EEO6051	Utilization of Electrical Power
P22EEO6052	Hybrid Electrical Vehicles
P22EEO6053	Energy auditing and DSM
P22EEO6054	Testing & Commissioning of Electrical Equipment

STRATEGIC MANAGEMENT AND ELECTRICAL ESTIMATION

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

SEMESTER – V

Course Code:	**P22EE501**	**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.
- Be able to plan, organize staff and schedule in both small and large organizations with an engineering context.
- The course helps students to discuss the purpose of estimation and costing.

UNIT – I	**Introduction**	**8 Hours**

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

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

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	**Introduction to Estimating and Costing**	**8 Hours**

Meaning of estimating, Purpose of estimating and costing, Market survey and source selection, Recording of estimates, Labour conditions, Determination of cost material, Purchase system, Purchase enquiry & selection of appropriate purchase mode, Comparative statement, Purchase Orders, Payment of Bills, Tender Form, General Idea about IE Rule, Indian Electricity(IE) Act and IE Rules-29,30,31,45,46,47,50,51,54,55,61, 77 and79.

Self-study component:	Construction, installation, protection, operation and maintenance of electricsupply lines and apparatus

1. **Source material to be referred**: Textbook 3: 1.1 to 1.18
2. **Learning Validation method:** Group Activities
3. **Pedagogy method used:** Chalk and talk, Power point presentation, case study.

UNIT – V	**Interior Wiring and Lightening system**	**8 Hours**

Introduction,selection of system, interior distribution system, specification of wiring materials and fixtures, code of practice for different types of wiring system. code Wire table for current rating for copper and aluminum cables, Quantity calculation and preparation of estimates for lighting installation, code of practice for power installation, material used and specification of power installation.

Self-study component:	Quantity calculation and estimating for power installation

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.

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	Ability to understand the theory of management, entrepreneurship and estimation.	Remember and Understand	L1, L2
CO2	Apply the principles of management, entrepreneurship and electrical estimation.	Apply	L3
CO3	Ability to analyze and communicate global, economic, legal and electrical estimation aspects.	Analyze	L4

CO4	Foster analytical and critical thinking abilities for electrical estimation and costing.	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. "A Course in Electrical Installation Estimating and Costing", J. B. Gupta Katson Books, 9th Edition,2012.
4. "Electrical Estimation", Raghavendra Rao, 2nd edition,2005.

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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Ability to understand the theory of management, entrepreneurship and estimation.	3	-	-	-	-	-	-	-	2	2	-	2	-	-
2	Apply the principles of management, entrepreneurship and electrical estimation.	3	-	-	-	-	-	-	-	2	2	-	2	-	-
3	Ability to analyze and communicate global, economic, legal and electrical estimation aspect	-	3	-	-	-	-	-	-	2	2	-	2	-	-
4	Foster analytical and critica thinking abilities for electrical estimation and costing.	-	3	-	-	-	-	-	-	-	2	2	2	-	-

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

POWER SYSTEM ANALYSIS & STABILITY

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

SEMESTER – V

Course Code:	**P22EE502**	**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**		

Utilization of Electrical Power [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22EE5031**	**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.

Self-study component:	Electric welding and their types

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**

Measurement & Instrumentation [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22EE5032**	**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	L3	Apply

	parameters of measuring instruments		
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 Outcomes**													
	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	

Special Electrical Machines [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22EE5033**	**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	Apply the knowledge of basic electrical laws to study the construction and operation of various Special Electrical Machines.	Understanding	L2
CO2	Analyze the performance characteristics of special Electrical Machines.	Applying	L3
CO3	Examine the control circuits for various special Electrical Machines.	Analyzing	L4
CO4	Solve the numerical problems on 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 Outcomes(CO)	**Program Outcomes**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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	

Data communications and Networking

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

SEMESTER – V

Course Code:	**P22EE5034**	**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													
		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 of Data Communication and Networking	3	-	-	-	-	-	-	2	2	2	-	2	-	-
2	Analyze the Network models, transmission media, error identification, LANS and switching	-	3	-	-	-	-	-	-	2	2	-	2	-	-
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**	

POWER ELECTRONICS (Integrated)

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

SEMESTER – V

Course Code:	**P22EE504**	**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. S**ource 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 phases 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, and 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 converters.	Applying	L3
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													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Apply the knowledge of basic science to study various types of semiconductor devices, their control 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
5	Conduct experiments on semiconductor devices and various types of converter/inverter circuits.	2	2	2	2	-	-	-	-	2	2	-	2	-	2

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

Solar PV Systems

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

SEMESTER –V

Course Code:	**P22EE505**	**Credits:**	**03**
Teaching Hours/Week(L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Theory Teaching Hours:	**40**	**SEE Marks:**	**50**

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

- Identify important parameters of batteries and their role in selection of batteries.
- Understand how to estimate number of batteries and connection types in battery banks.
- Understand Battery maintenance procedure and fault detection methods.
- Discuss the impact of PV Systems on ecology and environment.

UNIT– I	**Solar Photovoltaic Energy**	**08 Hours**

Basics of Electricity, DC and AC Power Measurement of Electrical Quantities, Basic Concepts about Energy and Its Use, Estimating Energy Requirement - Energy from Solar Photovoltaic (PV) Conversion-Solar PV Modules-Solar PV Systems and Advantages and Challenges of Solar Photovoltaic Energy Conversion.

Self-study component:	Other Renewable Energy Technologies

Textbook Map: 1.1 to 1.9 and 2.1 to 2.3 Indicated Textbook1, Chapter 1 and 2

Teaching Learning Process: Chalk and Talk, Power Point Presentation, Smart Board.

UNIT– II	**Solar Cells, PV Modules and Arrays**	**08 Hours**

Parameters of Solar Cells, Factors affecting Electricity generated from a Solar Cell , Solar PV Modules Ratings , Module Parameters, Factors Affecting Electricity Generated by a Solar PV Module, Solar PV Module Arrays - Connection of Modules in Series, in Parallel and in Series and Parallel (Mixed Combination).

Self-study component:	Factors Affecting Electricity Generated by a Solar Cell

Textbook Map: 3.4 to 3.5, 4.4 and 5.1 to 5.3 Indicated Textbook 1, Chapter 3, 4 and 5.

Teaching Learning Process: Chalk and Talk, Power Point Presentation, Smart Board.

UNIT– III	**Solar PV System Design**	**08 Hours**

Types of Solar PV Systems, Standalone, Grid-connected and Hybrid, Design Methodology for SPV System, Grid-connected Solar PV Power Systems- Introduction, Components and Configurations, Grid connected PV System Design for Small and Power Applications.

Self-study component:	Configuration of Grid-connected Solar PV Systems.

Textbook Map: 10.1 to 10.2 and 11.1 to 11.1.2 Indicated Textbook 1, Chapter 10 and 11.

Teaching Learning Process: Chalk and Talk, Power Point Presentation, Smart Board.

UNIT– IV	Charge Controller, MPPT and Inverters	08 Hours
Need For Balance of System (BoS), Power Converters and their efficiency, DC to AC Converters (Inverters), DC to DC Converters, Charge Controllers, Maximum Power Point Tracking (MPPT), Types of Wires and Wire Sizing, Junction Box.		
Self-study component:	Specifications of MPPT Charge Controller.	
Textbook Map:8.1 to 8.7 Indicated Textbook 1, Chapter 8		
Teaching Learning Process: Chalk and Talk, Power Point Presentation, Smart Board.		
UNIT– V	**Batteries and Their Applications To Solar PV Systems**	**08 Hours**
Types of batteries, Parameters of Batteries, How to select a battery, Connecting Batteries together Series, Parallel and mixed combination, Estimating Number of Batteries to be Connected in a battery Bank, Testing and Maintenance of Batteries, Fault Detection.		
Self-study component:	Tools Required for Battery Maintenance	
Textbook Map: 6.4 to 6.6 and 7.1 to 7.17 Indicated Textbook 1, Chapter 6 and 7.		
Teaching Learning Process: 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	Describe the basics of Power and Energy calculations in relation to SPV Systems and Importance of balance of System and MPPT.	Understand and Remember	L1&L 2
CO2	Interpret the parameters of PV Modules and their connections to form Arrays.	Apply	L3
CO3	Analyze the types of batteries and their necessity for remote applications of Solar PV Systems.	Analyze	L4
CO4	Demonstrate the design, integration and economics of PV Systems.	Design	L5

Text Book(s):

1. Chetan Singh Solanki ,Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, PHI Learning Publications, 3rd Edition, 2015.

Reference Book(s):

1. Roger A. Messenger and Jerry Ventre, 'Photovoltaic Systems Engineering', Taylor and Francis Group Publications, 3rd Edition, 2010(CRC Press Reprint – 2018)
2. Soteris A. Kalogirou, Solar Energy Engineering: Processes and Systems, Academic Press, (Elsevier) 2nd edition ,2014.

Course Outcomes		Program Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	Describe the basics of Power and Energy calculations in relation to SPV Systems and Importance of balance of System and MPPT.	3	3	1	-	-	2	-	-	-	-	-	2	3	2
2	Interpret the parameters of PV Modules and their connections to form Arrays.	2	3	3	-	-	2	-	-	-	-	-	2	2	2
3	Analyze the types of batteries and their necessity for remote applications of Solar PV Systems.	2	3	3	-	-	2	-	-	-	-	-	2	2	2
4	Demonstrate the design, integration and economics of PV Systems.	2	3	3	-	-	2	-	-	-	-	-	2	2	2
1-Low		**2-Medium**												**3-High**	

Course Title: Computer Aided Electrical Drawing [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22EEL506**	**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 discuss the generating and substation equipment, their location in a station and development of a layout for generating and substation.
- To discuss the terminology of DC and AC armature windings.
- To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
- To discuss different sectional views of transformers and its parts
- To explain development of sectional views of Transformers using the design data, sketches.
- To discuss the different types of wiring diagrams, and development of a layout for residential and workshop.

Sl.No	List of Experiments	No. of Hours
1.	Single Line Diagrams of Generating Stations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalized Single, Main and Transfer, Double Bus Double Breaker, Sectionalized Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main), Power Transformers, Circuit Breakers, Isolators, Earthing Switches, Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power- Line Carrier) and Line Trap	**2**
2.	Single Line Diagrams of Substations Covering Incoming Circuits, Outgoing Circuits, Busbar Arrangements (Single, Sectionalized Single, Main and Transfer, Double Bus Double Breaker, Sectionalized Double Bus, One and a Half Circuit Breaker Arrangement, Ring Main), Power Transformers, Circuit Breakers, Isolators, Earthing Switches, Instrument Transformers, Surge or Lightning Arresters, Communication Devices (Power- Line Carrier) and Line Trap	**2**
3.	Develop Winding Diagrams of D.C. Machines: Simplex Single Layer Lap Windings.	**2**
4.	Develop Winding Diagrams of D.C. Machines: Simplex Single Layer Wave Windings.	**2**

5.	Develop Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.	**2**
6.	Develop winding diagrams of A.C. machines integral slot full pitched single layer Lap and Wave windings.	**2**
7.	Develop winding diagrams of A.C. machines integral slot full pitched double layer Lap and Wave windings.	**2**
8.	Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Transformers - Sectional Views of Single-Phase Core Type Transformers.	**2**
9.	Draw the layout diagram of residential building. It is to be wired up with AEH installation and indicates all the fixtures.	**2**
10.	Draw the wiring plane of a small work shop with three lathes, one drilling machine, one welding machine and one grinding machine.	**2**

Text Book:

1. A course in Electrical Machine design, A. K. Sawhney, DhanpatRaipublishers,6th Edition, 2013
2. Electrical Engineering Drawing, K. L. Narang, Satya Prakashan Publication, 3rd Edition 2014.

Reference Books:

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

Course Articulation Matrix (CAM)

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	Understand and develop the Single Line and layout diagram of Power System Components.	3	3	-	-	3	-	-	-	-	-	-	-	2	-
2	Apply the knowledge and design the winding diagram of AC and DC machines.	3	2	3	-	3	-	-	-	-	-	-	-	2	2
3	Understand and develop the assembly diagram of AC machines.	-	-	-	-	-	-	-	1	3	3	-	-	-	-
1 – Low							**2 – Medium**							**3 – High**	

Internship - II [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P22INT507**	**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:	**P22HSMC508B**	**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:	**P22UHV509**	**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

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

SEMESTER – VI

Course Code:	**P22EE601**	**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 matrices and network matrices.	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	Analyze load flow studies, economic generation schedule and transient stability of a power system.	-	3	-	-	-	-	-	-	-	-	-	-	2	-
3	Solve the problems on load flow analysis, economic load dispatch and transient stability.	3	-	-	-	-	-	-	-	-	-	-	-	2	-
4	Solve the problems related to Power system using suitable software.	-	3	-	-	3	-	-	-	-	-	-	-	2	-

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

PLC & SCADA [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EE6021**	**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 its 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 Hardware& 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													
		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, 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**

Renewable Energy Sources [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EE6022**	**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), and 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	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	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**

Electrical Machine Design

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

SEMESTER – VI

Course Code:	**P22EE6023**	**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													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	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**	

Power Quality

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

SEMESTER – VI

Course Code:	**P22EE6024**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

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 v/s 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	Apply the knowledge of electrical engineering to study power quality issues.	L3	Apply
CO2	Analyze the impact of PQ issues on various electrical components	L3	Analyze
CO3	Solve numerical problems on power quality issues	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													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	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**

Course Title: Switchgear And Protection

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

SEMESTER VI

Course Code:	**P22EE6031**	**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	PSO 2
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**	

Embedded system & IoT

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

SEMESTER – VI

Course Code:	**P22EE6032**	**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 v/s 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, and 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													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	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**

DSP Processor and Applications

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

SEMESTER – VI

Course Code:	**P22EE6033**	**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, 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**													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	Apply the 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**		

Flexible AC Transmission Systems [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EE6034**	**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 betweenSVC 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	PSO 1	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

Control Systems (Integrated) [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EE604**	**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:

- 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	Understand the basic concepts of linear control systems.	Remember or Understand	L1,L2
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	PO4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	Understand the basic concepts of linear control 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**	

Utilization of Electrical Power

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

SEMESTER – VI

Course Code:	**P22EEO6051**	**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.

Self-study component:	Electric welding and their types

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, and 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**	

Hybrid Electric Vehicles [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EEO6052**	**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:

- 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 of HEV's	Applying	L3
CO2	Construct the architecture and power technologies of Plug-	Applying	L3

	in EVs		
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**	

Energy Auditing & Demand Side Management [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EEO6053**	**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	P O7	PO 8	PO 9	PO 10	P O11 1	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**	

Course Title: Testing and commissioning of Electrical Equipments SEMESTER VI			
Course Code:	**P22EEO6054**	**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, and 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, Buchholz & 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. 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 GearHandbook -Transformers-BHEL, J &P, J & P
.

Course Outcomes		Program Outcomes													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PS O1	P S O 2
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**	

Power System Simulation Laboratory [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22EEL606**	**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	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2
1	Apply the knowledge of power systems for formation of Ybus with and without mutual coupling using MATLAB Programming	3	3	-	-	3	-	-	-	-	-	-	-	2	-
2	Conduct experiments to execute programs to study loadflow, 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**	

Mini - Project [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P22ISMP607**	**Credits:**	**02**
Teaching Hours/Week (L:T:P)	**0:0:2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**26**	**SEE Marks:**	**50**

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students. (or Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications)

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. **The marks awarded for the project report shall be the same for all the batch mates.**

(ii) **Interdisciplinary**: CIE shall be group-wise at the college level with the participation of all the guides of the college through Dean (III). The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE for Mini-project:

- **Single discipline**: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department through Viva-Voce examination.
- **Interdisciplinary**: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) through Viva-Voce examination conducted separately at the departments to which the student/s belongs to.

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:	**P22HSMC608B**	**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:	**P22UHV609**	**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.
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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)
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Web links and Video Lectures (e-Resources):

Value Education websites,

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- 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
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- https://www.youtube.com/watch?v=sDxGXOgYEKM