ELECTRICAL ENGINEERING

SCHOOL OF ENGINEERING & TECHNOLOGY

GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY UNIVERSITY, ODISHA, GUNUPUR

CURRICULUM

FOR

BACHELOR OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING

2023-27

Annexure – XI

CO – PO mapping & attainment procedure as per new OBE standards

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.			
Competency		**Indicators**	
1.1	Demonstrate competence in mathematical modelling	1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems
		1.1.2	Apply advanced mathematical techniques to model and solve mechanical engineering problems
1.2	Demonstrate competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply fundamental engineering concepts to solve engineering problems
1.4	Demonstrate competence in specialized engineering knowledge to the program	1.4.1	Apply Electrical & Electronics engineering concepts to solve engineering problems.

CO	CO Statements	Indicators	PO 1	PO 1: Avg.
CO 1		1.1 to 1.4		
CO 2		1.1 to 1.4		
CO 3		1.1 to 1.4		
CO 4		1.1 to 1.4		
CO 5		1.1 to 1.4		
CO 6		1.1 to 1.4		

PO 2: Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.			
Competency		**Indicators**	
2.1	Demonstrate an ability to identify and formulate complex engineering problem	2.1.1	Articulate problem statements and identify objectives
		2.1.2	Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1	Reframe complex problems into interconnected sub-problems
		2.2.2	Identify, assemble and evaluate information and resources.
		2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
		2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a model	2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
		2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4		2.4.1	Apply engineering mathematics and computations to solve mathematical models

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	Demonstrate an ability to execute a solution process and analyse results	2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models
		2.4.3	Identify sources of error in the solution process, and limitations of the solution.
		2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

CO	CO Statements	Indicators	PO 2	PO 2: Avg.
CO 1		2.1 to 2.4 [13]		
CO 2		2.1 to 2.4 [13]		
CO 3		2.1 to 2.4 [13]		
CO 4		2.1 to 2.4 [13]		
CO 5		2.1 to 2.4 [13]		
CO 6		2.1 to 2.4 [13]		

PO 3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.			
Competency		**Indicators**	
3.1	Demonstrate an ability to define a complex/ open-ended problem in engineering terms	3.1.1	Recognize that need analysis is key to good problem definition
		3.1.2	Elicit and document, engineering requirements from stakeholders
		3.1.3	Synthesize engineering requirements from a review of the state-of-the-art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards such as IEEE, ECBC, BIS, ISO, Ele. Reg. Authorities etc.,
		3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
		3.2.2	Build models/prototypes to develop a diverse set of design solutions
		3.2.3	Identify suitable criteria for the evaluation of alternate design solutions
3.3	Demonstrate an ability to select an optimal design scheme for further development	3.3.1	Apply formal decision-making tools to select optimal engineering design solutions for further development
		3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4	Demonstrate an ability to advance an engineering	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)

	design to defined end state	3.4.2	Generate information through appropriate tests to improve or revise the design

CO	CO Statements	Indicators	PO 3	PO 3: Avg.
CO 1		3.1 to 3.4 [13]		
CO 2		3.1 to 3.4 [13]		
CO 3		3.1 to 3.4 [13]		
CO 4		3.1 to 3.4 [13]		
CO 5		3.1 to 3.4 [13]		
CO 6		3.1 to 3.4 [13]		

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Competency		Indicators	
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem, its scope and importance for purposes of investigation
		4.1.2	Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
		4.1.4	Establish a relationship between measured data and underlying physical principles
4.2	Demonstrate an ability to design experiments to solve open-ended problems	4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures
		4.2.2	Understand the importance of the statistical design of experiments and choose an appropriate experimental design plan based on the study objectives
4.3	Demonstrate an ability to analyse data and reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
		4.3.2	Analyse data for trends and correlations, stating possible errors and limitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
		4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions

CO	CO Statements	Indicators	PO 4	PO 4: Avg.
CO 1		4.1 to 4.3 [10]		

CO 2		4.1 to 4.3 [10]		
CO 3		4.1 to 4.3 [10]		
CO 4		4.1 to 4.3 [10]		
CO 5		4.1 to 4.3 [10]		
CO 6		4.1 to 4.3 [10]		

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

Competency		**Indicators**	
5.1	Demonstrate an ability to identify/ create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools such as computer-aided drafting, modeling and analysis; techniques and resources for engineering activities
		5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2	Demonstrate an ability to select and apply discipline-specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using discipline-specific tools
5.3	Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem	5.3.1	Discuss limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

CO	**CO Statements**	**Indicators**	**PO 5**	**PO 5: Avg.**
CO 1		5.1 to 5.3 [6]		
CO 2		5.1 to 5.3 [6]		
CO 3		5.1 to 5.3 [6]		
CO 4		5.1 to 5.3 [6]		
CO 5		5.1 to 5.3 [6]		
CO 6		5.1 to 5.3 [6]		

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			
Competency		**Indicators**	
6.1	Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public

CO	CO Statements	Indicators	PO 6	PO 6: Avg.
CO 1		6.1 to 6.2 [2]		
CO 2		6.1 to 6.2 [2]		
CO 3		6.1 to 6.2 [2]		
CO 4		6.1 to 6.2 [2]		
CO 5		6.1 to 6.2 [2]		
CO 6		6.1 to 6.2 [2]		

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.			
Competency		Indicators	
7.1	Demonstrate an understanding of the impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline

CO	CO Statements	Indicators	PO 7	PO 7: Avg.
CO 1		7.1 to 7.2 [4]		

CO 2		7.1 to 7.2 [4]		
CO 3		7.1 to 7.2 [4]		
CO 4		7.1 to 7.2 [4]		
CO 5		7.1 to 7.2 [4]		
CO 6		7.1 to 7.2 [4]		

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
Competency		**Indicators**	
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of the ECBC, Ele. Act. Etc., professional code of ethics
		8.2.2	Examine and apply moral & ethical principles to known case studies

CO	**CO Statements**	**Indicators**	**PO 8**	**PO 8: Avg.**
CO 1		8.1 to 8.2 [3]		
CO 2		8.1 to 8.2 [3]		
CO 3		8.1 to 8.2 [3]		
CO 4		8.1 to 8.2 [3]		
CO 5		8.1 to 8.2 [3]		
CO 6		8.1 to 8.2 [3]		

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
Competency		**Indicators**	
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team
		9.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual and team operations-- communication, problem-solving, conflict resolution and leadership skills	9.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
		9.2.2	Treat other team members respectfully
		9.2.3	Listen to other members
		9.2.4	Maintain composure in difficult situations
9.3	Demonstrate success in a team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts

CO	CO Statements	Indicators	PO 9	PO 9: Avg.
CO 1		9.1 to 9.3 [7]		
CO 2		9.1 to 9.3 [7]		
CO 3		9.1 to 9.3 [7]		
CO 4		9.1 to 9.3 [7]		
CO 5		9.1 to 9.3 [7]		
CO 6		9.1 to 9.3 [7]		

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

Competency		Indicators	
10.1	Demonstrate an ability to comprehend technical literature and document project work	10.1.1	Read, understand and interpret technical and non-technical information
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents
		10.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and viewpoints of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation

CO	CO Statements	Indicators	PO 10	PO 10: Avg.
CO 1		10.1 to 10.2 [7]		
CO 2		10.1 to 10.2 [7]		
CO 3		10.1 to 10.2 [7]		
CO 4		10.1 to 10.2 [7]		
CO 5		10.1 to 10.2 [7]		
CO 6		10.1 to 10.2 [7]		

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.			
Competency		Indicators	
11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyse different forms of financial statements to evaluate the financial status of an engineering project
11.2	Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1	Analyse and select the most appropriate proposal based on economic and financial considerations.
11.3	Demonstrate an ability to plan/manage an engineering activity within time and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project, so it is completed on time and on budget

CO	CO Statements	Indicators	PO 11	PO 11: Avg.
CO 1		11.1 to 11.3 [5]		
CO 2		11.1 to 11.3 [5]		
CO 3		11.1 to 11.3 [5]		
CO 4		11.1 to 11.3 [5]		
CO 5		11.1 to 11.3 [5]		
CO 6		11.1 to 11.3 [5]		

PO 12: Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
Competency		**Indicators**	
12.1	Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1	Describe the rationale for the requirement for continuing professional development
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.2	Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
		12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
12.3	Demonstrate an ability to identify and access sources for new information	12.3.1	Source and comprehend technical literature and other credible sources of information
		12.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Level	Descriptor	Level of attainment
1	Remembering	Recalling from the memory of the previously learned material
2	Understanding	Explaining ideas or concepts
3	Applying	Using the information in another familiar situation
4	Analysing	Breaking information into the part to explore understandings and relationships
5	Evaluating	Justifying a decision or course of action
6	Creating	Generating new ideas, products or new ways of viewing things

SEMESTER:

NBA CODE	SUBJECT CODE:	NAME OF THE SUBJECT	Category	Credits

Course	DIRECT ATTAINMENT (80% EXTERNAL +20% INTERNAL)											
	Targeted Percentage of COs						Attainment Percentage of COs					
	CO1	CO2	CO3	CO4	CO5	CO6	CO1	CO2	CO3	CO4	CO5	CO6
C101 (80% External + 20% Internal)												

Course	INDIRECT ATTAINMENT					
	Attainment Percentage of COs					
	CO1	CO2	CO3	CO4	CO5	CO6
C101						

Course	FINAL ATTAINMENT (80 % DIRECT+20% INDIRECT)					
	Attainment Percentage of COs					
	CO1	CO2	CO3	CO4	CO5	CO6
80% (DIRECT)						
20% (INDIRECT)						
TOTAL ATTAINMENT						
TARGET						
ACHIEVED (YES/NO)						

Annexure – VIII

PSO & PEO

PSO1:
Focus on hybrid energy conversion, management and auditing in specific industry applications and sustainable rural development.

PSO2:
To design, simulate and practice the techniques of hardware and software tools in Smart Renewable Energy systems.

PSO3:
Work professionally in multidisciplinary data analytic concepts by using Internet of Things, Artificial Intelligence, and smart sustainable technologies.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO-1: Success in core Engineering:
To provide the necessary skills in Electrical & Electronics Engineering and allied fields by imbibing higher education concepts

PEO-2: Industrial awareness and research:
To enhance technical knowledge and skills to solve complex industry tasks through research with innovative approaches.

PEO-3: Globally employable and entrepreneur skills:
To create novel designs, economically viable and socially acceptable products, and become future entrepreneurs

PEO-4: Professional and societal environment:
To be involved in lifelong learning, career enhancement, and adapting to changing technologies with high ethical values

Structure of Undergraduate Engineering Program:

CREDIT DISTRIBUTION

	Course Category	CODE	Credits / Semester								TOTAL	Percentage	AICTE
			I	II	III	IV	V	VI	VII	VIII			
1	Humanities and Social Sciences, including Management courses	HS	4	3	2	2	2	2	3		18	11	12*
2	Basic Science courses	BS	7	5	4						16	10	25*
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/ computer, etc	ES	11	14	4	4					33	20	24*
4	Professional core courses	PC			11	14	12	11	4		52	32	48*
5	Professional Elective courses relevant to the chosen specialization/branch	PE					3	3	6	6	18	11	18*
6	Open subjects – Electives from other technical and /or emerging subjects	OE					3	3	3	3	12	7	18*
7	Project work, seminar, and internship in industry or elsewhere	PST			1	1	2	1	4	6	15	9	15*
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	MC											NC
			22	**22**	**22**	**21**	**22**	**20**	**20**	**15**	**164**	**100**	

*Minor variation is allowed as per the needs of the respective disciplines

Code and Definition:

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
BS	Basic Science Courses
ES	Engineering Science Courses
HS	Humanities and Social Sciences including Management Courses
PC	Professional Core Courses
PE	Professional Elective Courses
OE	Open Elective Courses
MC	Mandatory Courses
PST	Project/Seminar/Training

A. Category of Courses:

I. Basic Science Courses

S.N.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Engineering Physics	3	0	0	3	I/II
2	Dietetics and Nutrition	1	0	0	1	I/II
3	Engineering Mathematics-I	3	1	0	4	I
4	Engineering Mathematics-II	3	1	0	4	II
5	Engineering Mathematics-III	3	1	0	4	III

II. Engineering Science Courses

S.N.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Basic Electrical and Electronics Engineering	3	0	0	3	I/II
2	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1	I/II
3	Elements of Mechanical Engineering	3	1	0	4	I/II
4	Fundamentals of Web Technologies	1	0	0	1	I/II
5	Fundamentals of Web Technologies Laboratory	0	0	4	2	I/II
6	Programming for Problem Solving	3	0	0	3	I
7	Programming for Problem-Solving Laboratory	0	0	4	2	I
8	Data Structure and Algorithms	3	0	0	3	II
9	Data Structure and Algorithms Laboratory	0	0	4	2	II
10	Engineering Graphics and Design	1	0	2	2	I/II
11	Engineering Workshop	1	0	2	2	I/II
12	Object-Oriented Programming using JAVA	3	0	0	3	III
13	Object-Oriented Programming using JAVA Laboratory	0	0	2	1	III
14	Database Management Systems	3	0	0	3	IV
15	Database Management Systems Laboratory	0	0	2	1	IV

III. Humanities and Social Sciences, including Management Courses

Sl. No.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Human Values and Professional Ethics	1	0	0	1	I/II
2	Communicative English and Soft Skills	2	0	0	2	I
3	Communicative English and Soft Skills Laboratory	0	0	2	1	I
4	Communicative English and Technical Communication	2	0	0	2	II
5	Communicative English and Technical Communication Laboratory	0	0	2	1	II
6	English Learning 01 - Resume Building and Email Writing	1	0	0	1	III
7	English Learning 01 - Resume Building and Email Writing Laboratory	0	0	2	1	III
8	English Learning 02 -	1	0	0	1	IV
9	English Learning 02 - Laboratory	0	0	2	1	IV
10	Organizational Behavior	2	0	0	2	V/VI
11	Engineering Economics and Costing	2	0	0	2	V/VI
12	Entrepreneurship Development	3	0	0	3	VII

IV. Professional Core Courses

S.N.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Electrical Machines - I	3	0	0	3	III
2	Network theory	3	0	0	3	III
3	Electromagnetic Fields	3	0	0	3	III
4	Electrical Machines - I lab	0	0	2	1	III
5	Network theory lab	0	0	2	1	III
6	Electrical Machines - II	3	0	0	3	IV
7	Control Systems	3	0	0	3	IV
8	Electrical Power Transmission and Distribution	3	0	0	3	IV
9	Analog and Digital Circuits	3	0	0	3	IV
10	Electrical Machines - II lab	0	0	2	1	IV
11	Control Systems lab	0	0	2	1	IV
12	Power Electronics	3	0	0	3	V
13	Microprocessors and Microcontrollers	3	0	0	3	V
14	Signals & Systems	3	0	0	3	V
15	Power Electronics Lab	0	0	2	1	V
16	Microprocessors and Microcontrollers Lab	0	0	2	1	V
17	Solar PV Lab	0	0	2	1	V
18	Electrical and Electronics Measurements	3	0	0	3	V
19	Power System Operation and Control	3	0	0	3	VI
20	PLC & SCADA	3	0	0	3	VI
21	IOT & Data Analytics Lab	0	0	2	1	VI
22	Electric Drives	0	0	2	1	VI
23	Simulation Lab	0	0	2	1	VI

V. Professional Elective Courses

[Any 5 from this basket of 15 Courses]

S.N.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Switch Gear & Protection	3	0	0	3	V
2	Switched Mode Power Conversion	3	0	0	3	V
3	Power Systems Deregulation	3	0	0	3	V
4	Electrical Engineering Materials	3	0	0	3	VI
5	Hybrid Electric Vehicles	3	0	0	3	VI
6	Electrical Standards & Electricity regulations	3	0	0	3	VI
7	Special Electrical Machines	3	0	0	3	VII
8	HVDC Transmission	3	0	0	3	VII
9	Power Station Engineering & Economy	3	0	0	3	VII
10	High Voltage Engineering	3	0	0	3	VII
11	Digital Signal Processing	3	0	0	3	VII
12	Power Quality	3	0	0	3	VII
13	Smart Grid Technologies	3	0	0	3	VIII
14	Battery Management Systems and Charging Stations	3	0	0	3	VIII
15	Advanced Control Systems	3	0	0	3	VIII
16	AI Applications to Electrical Engineering	3	0	0	3	VIII
17	Utilization of Electrical Energy	3	0	0	3	VIII
18	Flexible Alternating Current Transmission Systems	3	0	0	3	VIII
19	Neural Networks and Fuzzy Logic	3	0	0	3	VIII
20	Computer Networks	3	0	0	3	VIII
21	Energy Auditing, Conservation and Management	3	0	0	3	VIII
22	EHV AC Transmission	3	0	0	3	VIII
23	Computer-Aided Electrical Drawing	3	0	0	3	VIII
24	Energy Storage Systems	3	0	0	3	VIII

VI. Open Elective Courses

Sl. No.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Renewable Energy Sources	3	0	0	3	VI
2	Computer Networks	3	0	0	3	VI
3	Fundamentals of Robotics	3	0	0	3	VI
4	Operation Research	3	0	0	3	VII
5	Internet of Things	3	0	0	3	VII
6	MEAN Stack Technologies	3	0	0	3	VII
7	Computer Architecture and Organization	3	0	0	3	VII
8	Linear IC Applications	3	0	0	3	VII
9	Introduction to Machine Learning	3	0	0	3	VII
10	Cloud Computing with AWS	3	0	0	3	VIII
11	Quantum Computing	3	0	0	3	VIII
12	Blockchain technologies	3	0	0	3	VIII
13	Hydrogen Energy and Fuel Cells	3	0	0	3	VIII
14	Big Data Analytics	3	0	0	3	VIII
15	Deep Learning Techniques	3	0	0	3	VIII
	Web Development	3	0	0	3	VIII

VII. Mandatory Courses

S.N..	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Induction Program	-	-	-	0	I
2	Sports and Yoga or NSS/NCC	-	-	-	0	II
3	Constitution of India	2	-	-	0	III
4	Essence of Indian Traditional Knowledge	2	-	-	0	III
5	Environmental Science	2	-	-	0	IV

*For mandatory non-credit courses, these will be graded as Pass or Fail (P/F). Thus, the grades obtained will not affect the grade point average. However, they will appear on the grade sheet.

VIII. Project/Seminar/Training

S.N.	Course Title	Hours per week			Credits	Preferred Semester
		L	T	P		
1	Summer Internship-I	-	-	-	1	III
2	Mini Project-I	0	0	2	1	IV
3	Mini Project-II	0	0	2	1	V
4	Summer Internship-II	-	-	-	1	V
5	Mini Project-III	0	0	2	1	VI
6	Technical Seminar	0	0	2	1	VII
7	Project Work-I	0	0	6	3	VII
8	Summer Internship-III	-	-	-	1	VII
9	Project Work II and Dissertation	0	0	12	6	VIII

IX. Exclusive Skill oriented / Job oriented Courses:

S.N.	**Course Title**	**Hours per week**			**Credits**	**Preferred Semester**
		L	**T**	**P**		
1	Solar PV lab	0	0	2	1	V
2	Renewable Energy Sources	3	0	0	3	V
3	IoT & Data Analytics Lab	0	0	2	1	V
4	Electric Vehicle Lab	0	0	2	1	VI
5	PLC & SCADA	3	0	0	3	VI
6	Hybrid Electric Vehicles	3	0	0	3	VI
7	Battery Management Systems and Charging Stations	3	0	0	3	VI
8	Smart Grid Technologies	3	0	0	3	VII
9	Utilization of Electrical Energy	3	0	0	3	VII
10	Energy Auditing, Conservation, and Management	3	0	0	3	VII
11	Energy Storage Systems	3	0	0	3	VIII
12	Computer-Aided Electrical Drawing	3	0	0	3	VIII

All these courses are integrated with Workshops, VACs, or hands-on experience with Industry Collaborations.

R2023
[2023-27]
III Semester [Second Year]
B. Tech in Electrical Engineering

S.N.	Category	Course Code	Course title	Hours/week			C	CIA	SEE
				L	T	P			
1	BS	23BBSBS23001	Engineering Mathematics – III	3	1	0	4		
2	PC	23BELPC23001	Electrical Machines - I	3	0	0	3		
3	PC	23BELPC23002	Network theory	3	0	0	3		
4	PC	23BELPC23003	Electromagnetic Fields Theory	3	0	0	3		
5	ES	23BCSES23001	OOP through JAVA	3	0	0	3		
6	HS	23BBSHS23001	English Learning 01- Resume Building and Email Writing	1	0	0	1		
PRACTICAL / SESSIONAL									
7	PC	23BELPC23101	Electrical Machines - I lab	0	0	2	1		
8	PC	23BELPC23102	Network theory lab	0	0	2	1		
9	ES	23BCSES23101	OOP through JAVA Lab	0	0	2	1		
10	PST	23BELPW23001	Summer Internship -I	0	0	2	1		
11	HS	23BBSHS23101	English Learning 01 - Resume Building and Email Writing Laboratory	0	0	2	1		
12	MC	23BMCMC20001	Constitution of India	-	-	-	0		
		23BMCMC20002	Essence of Indian Traditional Knowledge						
			TOTAL	16	1	10	22		
			Cumulative Total	46	4	54	66		

Subject Code	Name of the Subject	L	T	P	C
	ENGINEERING MATHEMATICS-III	3	1	0	4

	Prerequisites:
1	Calculus and Algebra: Basic understanding of differentiation, integration, series, algebraic equations, and transcendental functions
2	Complex Numbers and Linear Algebra: Familiarity with complex number operations, polar/exponential forms, and basic linear algebra concepts like matrices and vector spaces.
3	Differential Equations: Knowledge of solving ordinary differential equations and an introductory understanding of partial differential equations
4:	Probability, Statistics, and Numerical Methods: Fundamental concepts in probability, statistics, and basic numerical methods for solving equations

	Course Educational Objectives
CEO1	To test the nature of the complex function
CEO2	To identify the different methods for complex integration
CEO3	To analyze errors by using different methods.
CEO4:	To know about different types of probability distributions.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understanding the concept of analytical function and the harmonic conjugate of the function.	2
CO2	Understand the concept of an elementary function and the complex integral using Cauchy's theorem and formula.	2
CO3	Evaluating Integral by using the concept of Residues, Numerical differentiation, and integration by using numerical methods	3
CO4	Apply the concept of interpolation of the interpolation polynomials.	3
CO5	Apply the concept of numerical differentiation and solve differential equations.	3
CO6	Investigate Probability distribution problems of the correlation and regression.	4

SYLLABUS

UNIT – I	**10 Hrs**
COMPLEX FUNCTIONS: Complex function, Continuity, Differentiability. Analytic function, Cauchy-Riemann equations, Harmonic Functions, Properties of analytic functions, Conformal Mapping (W = C Z, C+ Z, & *1/Z)* Bilinear Transformation.	
UNIT – II	**12 Hrs.**
COMPLEX INTEGRATION Power series, radius of convergence, Taylor's series, Laurent's series. Line integral, Cauchy's integral theorem, Cauchy's integral formula., Zeros and Singularities, Residues, Cauchy Residue theorem, Evaluation of real integrals.	
UNIT – III	**12 Hrs.**
NUMERICAL METHODS: Solution of algebraic and transcendental equations by using fixed point iteration method and Newton-Raphson's method, Regula-Falsi method. Newton's Forward and Backward Difference Interpolation, Newton's divided Difference interpolation formula, Lagrange's interpolation	
UNIT – IV	**10 Hrs.**

NUMERICAL DIFFERENTIATION AND INTEGRATION (12 Hours)

Numerical Differentiation, Numerical integration: Trapezoidal rule, Simpson's $1/3^{rd}$ and Simpson's $3/8^{th}$ rules

UNIT – V	**12 Hrs.**

NUMERICAL SOLUTION OF ODE and STATISTICS

Solution of Ordinary differential equation -Taylor's Series, Euler's method, Modified Euler's method, Runge-Kutta methods. Correlation and Regression analysis, fitting of a straight line by the least square method.

Mode of Teaching:

Text Books:

1. Advanced Engineering Mathematics by E. Kreyszig, Tenth Edition, Willey
2. Numerical Methods by Jain and Iyengar.

Reference Books:

1. Higher Engineering Mathematics by BS Grewal : Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by B. V. Ramana, McGraw Hills Education
3. Numerical Methods by Dutta and Jena.

Subject Code	Name of the Subject	L	T	P	C
	ELECTRICAL MACHINES – I	3	0	0	3

	Prerequisites:
1	Basic Electrical Engineering: Understanding of fundamental electrical concepts, including Ohm's Law, Kirchhoff's laws, AC/DC circuits, and the principles of electromagnetism.
2	Electromagnetic Theory: Familiarity with magnetic fields, electromagnetic induction, Faraday's and Lenz's laws, and the behavior of magnetic materials.
3	Basic Circuit Theory: Knowledge of analyzing electrical circuits, including series and parallel circuits, Thevenin's and Norton's theorems, and basic network theorems.
4:	Mathematics for Engineers: Proficiency in calculus, differential equations, and linear algebra to model and analyze electrical systems

	Course Educational Objectives
CEO1	Equip students with DC generators and motors knowledge for analyzing and optimizing DC machines in engineering applications.
CEO2	Enable students to analyze the efficiency and operation of single-phase and three-phase transformers for practical electrical systems use
CEO3	Introduce students to emerging electric machine technologies, fostering innovation in modern electrical engineering.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Explain the construction, operation, and performance characteristics of DC generators.	2
CO2	Describe various DC motors' working principles, characteristics, and control methods.	2
CO3	Analyze the construction, operation, and efficiency of single-phase transformers.	4
CO4	Examine the different connection methods and operational features of three-phase transformers.	4
CO5	Explore the construction and operation of BLDC machines, drone motors, and energy-efficient transformers.	3
CO6	Integrate knowledge of DC machines, transformers, and emerging motor technologies to design and optimize electrical systems.	6

SYLLABUS

UNIT – I	**8 Hrs**

DC GENERATORS:

Introduction, construction, types, EMF equation, lap and wave windings, armature reaction, commutation, methods of improving commutation, equalizer rings. Demagnetizing and cross magnetizing ampere turns, various characteristics of shunt, series and compound generators, voltage build up, losses and efficiency, condition for maximum efficiency.

UNIT – II	**8 Hrs.**

DC Motors:

Introduction, principals, back-emf, torque of motor, types, characteristics of shunt, series and compound motors, speed control (field and armature control methods), basic idea of solid state devices in controlling of DC motors, Starting of DC motors, three-point and four-point starters, losses and efficiency, testing (brake test and Swinburne's test), electric braking of DC motors, Applications.

UNIT – III	10 Hrs.

Single Phase Transformers: Constructional details, Core, windings, Insulation, principle of operation, EMF equation, magnetizing current and core losses, no load and on load operation, Phasor diagram, equivalent circuit, losses and efficiency, condition for maximum efficiency, voltage regulation, approximate expression for voltage regulation, open circuit and short circuit tests, Sumpner's test, Inrush of switching currents, harmonics in single phase transformers, Parallel operation of transformers.

Autotransformers - construction, principle, applications and comparison with two winding transformers.

UNIT – IV	8 Hrs.

Three phase transformers: Three phase Transformer: Constructional features of three phase transformers – three phase connection of transformers (Dd0, Dd6, Yy0, Yy6, Dy1, Dy11, Yd1, Yd11, zigzag), Scott connection, open delta connection, three phase to six phase connection, oscillating neutral, tertiary winding, three winding transformer, equal and unequal turns ratio, parallel operation, load sharing, Distribution transformers, all day efficiency.

UNIT – V	6 Hrs.

Construction and Principle of operation of BLDC Machine, Types of drone motors, Basic idea of welding transformer, energy efficient motors, and smart transformers.

Mode of Teaching:

Text Books:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

Reference Books:

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
2. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
3. A Textbook of Electrical Technology - Volume II By BL Theraja

Subject Code	Name of the Subject	L	T	P	C
	NETWORK THEORY	3	0	0	3

	Prerequisites:
1	Basic Electrical Engineering: Understanding of fundamental electrical concepts, including Ohm's Law, Kirchhoff's laws, AC/DC circuits, and the principles of electromagnetism.
2	Electromagnetic Theory: Familiarity with magnetic fields, electromagnetic induction, Faraday's and Lenz's laws, and the behavior of magnetic materials.
3	Basic Circuit Theory: Knowledge of analyzing electrical circuits, including series and parallel circuits, Thevenin's and Norton's theorems, and basic network theorems.
4:	Mathematics for Engineers: Proficiency in calculus, differential equations, and linear algebra to model and analyze electrical systems

	Course Educational Objectives
CEO1	Enable students to analyze and solve complex electrical circuit problems using fundamental theorems and concepts.
CEO2	Equip students with the skills to analyze and design electrical networks using two-port parameters, transforms, and positive real functions.
CEO3	Enable students to design efficient filters and drive point functions for various electrical applications.

	Prerequisites
1	Basic Electrical Engineering: Understanding of fundamental electrical concepts, including voltage, current, resistance, Ohm's law, Kirchhoff's laws, and basic circuit analysis techniques.
2	Mathematics: Proficiency in calculus, differential equations, and linear algebra to handle complex circuit analysis, Laplace transforms, and Fourier analysis.
3	Physics: Basic knowledge of electromagnetism, including concepts of inductance, capacitance, and magnetic fields, to comprehend coupled circuits and resonance

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze electrical circuits using fundamental theorems and evaluate resonant and coupled circuit behavior.	4
CO2	Examine two-port network parameters and assess the significance of poles and zeros in network functions.	5
CO3	Apply Laplace and Fourier transforms to solve network problems, including steady-state and transient responses.	3
CO4	Synthesize driving point functions for R-L, R-C, and L-C networks and understand the properties of positive fundamental functions	6
CO5	Design various filters based on characteristic impedance, including Low Pass, High Pass, Band Pass, and Band Stop filters.	6
CO6	Integrate knowledge of circuit analysis, network theorems, and filter design to solve complex electrical network problems.	6

SYLLABUS UNIT – I	8 Hrs
Basic of electrical circuits, Superposition theorem, Thevenin's theorem, Norton's Theorem, Reciprocity Theorem, Maximum Power transfer theorem, Tellegen's theorem, and Millman's theorem, Band Width and Q-factor for series and parallel resonant circuits, Coupled circuits, coefficient of coupling, self & mutual inductance, Dot Convention for representing coupled circuits, series aiding & opposing.	
UNIT – II	**8 Hrs.**
Z, Y, H, ABCD parameters, Condition of reciprocity and symmetry, Interrelation of two-port parameters, Interconnection of two-port networks, Significance of Poles and Zeros, Restriction on location of Poles and Zeros, Time domain behaviour from Pole-Zero plots.	
UNIT – III	**10 Hrs.**
Laplace transform of some basic functions, Laplace transform of periodic functions, Inverse Laplace transform, Application of Laplace transform: Circuit Analysis (Steady State and Transient), Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to periodic signals, Fourier transform and convergence, Fourier transform of some functions.	
UNIT – IV	**8 Hrs.**
Hurwitz property, Positive realness, properties of positive real functions, Synthesis of R-L, R-C, and L-C driving point functions in Foster and Cauer forms, An overview of network filters.	
UNIT – V	**6 Hrs.**
Filters Need of Filters – Classification -Characteristic impedance- Low Pass Filter, High Pass Filter, Band Pass Filter, Band Stop or Band Elimination Filter, m-Derived Filter, Composite filters– Design of Filters.	
Mode of Teaching:	
Text Books: 1. A.Chakrabarti - Circuit Theory: Analysis and Synthesis , 6th edition, Dhanpat Rai & Co. 2. Fundamentals of Electric Circuits – Alexander & Sadiku– Tata McGraw Hil, 5thEditionl.	
Reference Books: 1. Network Analysis – M E Van Valkenburg – Pearson Education, 3rd Edition. 2. Theory and problem of electrical circuits, Schaum's Outline Series, TMH – Joseph A. Edminister, MahmoodMaqvi. 3. Electric Circuits – David A.Bell – Oxford, 7th Edition, 2015. 4. M.S.Sukhija & T.K.NagSarkar- Circuits and Networks-Oxford.	

Subject Code	Name of the Subject	L	T	P	C
	ELECTROMAGNETIC FIELDS THEORY	3	0	0	3

	Prerequisites
1	Basic Mathematics: Understanding of calculus and vector calculus, including differentiation, integration, and coordinate systems.
2	Fundamentals of Physics: Knowledge of basic physics principles, especially in electrostatics and magnetostatics.
3	Introduction to Electrical Engineering: Familiarity with basic electrical engineering concepts and simple circuit theory.

	Course Educational Objectives
CEO1	Develop a strong understanding of vector analysis and coordinate systems for solving problems in different coordinate frameworks.
CEO2	Apply fundamental electrostatic and magnetostatic laws to analyze electric and magnetic fields in various physical scenarios.
CEO3	Understand and analyze electromagnetic wave propagation and apply Maxwell's equations to solve engineering problems involving electromagnetic fields.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand vector analysis and coordinate systems, including interconversion between Cartesian, cylindrical, and spherical systems.	2
CO2	Apply the principles of Coulomb's Law, Gauss's Law, and electric potential to calculate electric fields and flux density and solve electrostatic problems.	3
CO3	Analyze magnetostatic fields using Biot-Savart's Law and Ampere's Circuital Law, focusing on magnetic field intensity, flux density, and potentials.	4
CO4	Explain electromagnetic wave propagation, including Faraday's Law, displacement current, and Maxwell's equations.	2
CO5	Calculate self and mutual inductance for solenoids, toroids, and wire loops, and understand energy storage in magnetic fields.	3
CO6	Integrate concepts from electrostatics, magnetostatics, and electromagnetic fields to analyze and solve engineering problems.	4

SYLLABUS

UNIT – I	**8 Hrs**

Introduction:

Introduction to scalars and vectors, dot product, cross product, and basic operations on vectors cartesian co-ordinate systems and problems on cartesian co-ordinate systems. Cylindrical coordinate systems and problems on cylindrical coordinate systems. spherical co-ordinate systems and problems on spherical co-ordinate systems. inter conversion between cartesian, cylindrical and spherical co-ordinate systems. inter conversion between cylindrical and spherical co-ordinate systems. inter conversion between cartesian and spherical co-ordinate systems. Differential length, Area & volume, and problems on it Del operator, Gradient of a scalar, Divergence of a vector & divergence theorem and numerical curl of a vector & Stoke's theorem, Laplacian of a scalar and numerical.'

UNIT – II	8 Hrs.

Electrostatic Fields:

Coulomb's Law and numerical. Electric Fields due to point, line, surface, Electric Fields due to volume charge Electric Flux Density Gauss's Law – Maxwell's Equation Applications of Gauss's Law and Numericals. Electric Potential, Relationship between E and V – Maxwell's Equation. Electric Dipole & Flux Lines and Numericals, Energy Density in Electrostatic Fields. Possion's & Laplace's Equations, Uniqueness theorem and Numericals. General procedures for solving Possion's or Laplace's Equation.

UNIT – III	10 Hrs.

Magnetostatic Fields:

Magnetic Field Intensity Biot-Savart's Law Ampere's circuit law- Maxwell's equation for static fields applications of Ampere's law Magnetic Flux Density-Maxwell's equations Maxwell's equation for static fields Magnetic Scalar potentials Magnetic Vector potentials.

UNIT – IV	8 Hrs.

Electromagnetic Fields and Wave Propagation:

Introduction Faraday's Law Transformer & Motional Electromagnetic Forces Displacement Current Maxwell's Equation in Final forms Time Varying Potentials Time-Harmonic Field Electromagnetic Wave Propagation Wave Propagation in loss Dielectrics Plane Waves in loss less Dielectrics Power & pointing vector.

UNIT – V	6 Hrs.

Self and mutual inductance:

Self and mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane – energy stored and density in a magnetic field.

Mode of Teaching:

Text Books:

1. Matthew N. O. Sadiku, Principles of Electromagnetics, 4th Ed., Oxford Intl. Student Edition.
2. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd, TMH.
3. W.H. Hyat, Electromagnetic Field Theory, 7th Ed, TMH.

Reference Books:

1. Edward C. Jordon , Keith G. Balmain," Electromagnetic Waves and Radiating Systems"2nd Ed, Pearson Education.
2. Fundamentals of Engineering Electromagnetics by Sunil Bhooshan, Oxford University Press, 2012.

Subject Code	Name of the Subject	L	T	P	C
	OOP through JAVA	3	0	0	3

	Prerequisites
1	Basic Programming Knowledge: Understanding of fundamental programming concepts such as variables, data types, control structures (if-else, loops), and basic syntax in any programming language (e.g., C, C++).
2	Introduction to Computer Science: Familiarity with core computer science concepts such as algorithms, flowcharts, and problem-solving techniques.
3	Mathematical Foundations: Basic knowledge of discrete mathematics, logic, and possibly some understanding of sets and functions, which are helpful in understanding programming logic and structures.
4	Basic Understanding of Data Structures: A foundational knowledge of data structures like arrays, stacks, queues, and linked lists is beneficial, although it might be taught concurrently.

	Course Educational Objectives
CEO1	Introduce the fundamentals of Object-Oriented Programming and Java basics.
CEO2	Equip students with the skills to apply control structures, arrays, and object-oriented principles in Java.
CEO3	Provide experience with advanced Java features like packages, file handling, exception management, and threading.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Explain the differences between Procedure Oriented and Object-Oriented Programming and the basic features of Java.	2
CO2	Implement control structures in Java, including loops and conditional statements, and manage arrays and strings.	3
CO3	Develop Java programs using classes and objects, applying inheritance, polymorphism, and abstract classes to enhance code reusability and flexibility.	3
CO4	Create Java packages for organizing code, and perform file input/output operations using Stream classes to manage data storage and retrieval.	3
CO5	Handle* exceptions in Java programs and manage threading for multitasking, ensuring robust and efficient execution of concurrent tasks.	3
CO6	Apply* Object-Oriented Programming principles and Java features to design and implement software solutions, addressing key programming challenges.	3

SYLLABUS

UNIT – I	**8 Hrs**
Introduction to OOPs: Problems in Procedure Oriented Approach, Features of Object-Oriented Programming. **Introduction to Java:** Features of Java, The Java Virtual Machine (JVM), Parts of Java program, Naming Conventions in Java, Data Types in Java, Operators in Java, Reading Input using scanner Class, Displaying Output using System. out. println (), Command Line Arguments.	
UNIT – II	**8 Hrs.**
Control Statements in Java:	
if... else, do... while Loop, while Loop, For loop, Switch Statement, break Statement, continue Statement, Arrays: Types of Arrays, array name, length, Strings: Creating Strings, String Class Methods, String Comparison, Immutability of Strings.	
UNIT – III	**10 Hrs.**

Classes and Objects: Object Creation, Initializing the Instance Variables, Access Specifiers, Constructors,

Inheritance: Inheritance, Types of Inheritance Polymorphism: Method overloading, Abstract Classes: Abstract Method and Abstract Class.

UNIT – IV	**8 Hrs.**

Packages:

Package, Different Types of Packages, Creating Package and Accessing a Package. Streams: Stream classes, creating a File using File Output Stream, Reading Data from a File using File Input Stream, Creating a File using File Writer, Reading a File using File Reader.

UNIT – V	**6 Hrs.**

Exception Handling:

Errors in Java Program, Exceptions, throws Clause, throw Clause, Types of Exceptions, Threads: Single Tasking, Multi-Tasking, Uses of Threads, Creating a Thread and Running it, terminating the Thread, Thread Class Methods.

Mode of Teaching:

Text Books:

1. The Complete Reference JAVA Seventh Edition Herbert Schildt. Tata McGraw Hill Edition.

Reference Books:

1. Core Java: An Integrated Approach, Dr. R. Nageswara Rao &Kogent Learning Solutions Inc.
2. E. Balaguruswamy, Programming with JAVA, A primer, 3e, TATA McGrawHill Company

Subject Code	Name of the Subject	L	T	P	C
	Intermediate Communication Skills and Critical Thinking.	1	0	0	1

	Prerequisites
1	Basic proficiency in English for understanding and communication
2	Introductory experience with communication skills, including listening, speaking, reading, and writing
3	Basic critical thinking skills for simple analysis and evaluation

	Course Educational Objectives
CEO1	To enhance students' ability to comprehend, interpret, and critically analyze spoken and written information
CEO2	To equip students with the skills and confidence necessary for effective communication, including public speaking and writing
CEO3	To foster critical thinking and problem-solving abilities by teaching students to apply analytical and creative thinking techniques

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Apply comprehensive listening techniques to interpret spoken information in various contexts effectively.	3
CO2	Demonstrate confidence in public speaking by overcoming stage fear and delivering effective speeches.	3
CO3	Develop writing proficiency through structured processes of pre-writing, drafting, and revising.	6
CO4	Enhance reading comprehension by employing strategies to analyze and interpret various texts.	4
CO5	Improve critical thinking abilities by differentiating between critical and lateral thinking and applying problem-solving strategies.	5
CO6	Integrate listening, speaking, writing, reading, and critical thinking skills for effective communication and analysis in various contexts.	6

SYLLABUS

UNIT – I	**4 Hrs**
Comprehensive Listening Skills • What and why • Techniques for improving listening skills	
UNIT – II	**4 Hrs.**
Public Speaking Skills • Public speaking: what and why • Overcoming stage fear • Techniques for effective speaking skill	
UNIT – III	**4 Hrs.**
Stages of Writing • Pre-Writing- selecting a topic	
• Writing- Free Writing, Drafting • Re-writing- Revision, editing, proofreading.	
UNIT – IV	**3 Hrs.**

Effective Reading Skills

- What is Reading Comprehension;
- Tips for effective reading;
- Techniques and types.

UNIT – V	**4 Hrs.**

Critical Thinking Skills

- What and Why
- Critical thinking vs. Lateral thinking
- Ways to improve Critical Thinking

Mode of Teaching:

Text Books:

1. Basic Communication Skills for Technology by Andrea J. Rutherford, Pearson Education Asia, Patparganj, New Delhi, 2001.
2. How to Read better and FasterbyNormanLewis.4thEdition. Publisher :Crowell, 1978

Reference Books:

1. The Kabuliwala and other stories by Rabindranath Tagore, Maple Classics, 2019.
2. The Gift of Magi by O Henry, Candlewick Press, 2008.

Subject Code	Name of the Subject	L	T	P	C
	Electrical Machines – I Lab	0	0	2	1

	Course Educational Objectives	
CEO1	Enable students to understand and determine critical parameters and efficiency of DC machines through various testing methods.	
CEO2	Equip students with skills to control and analyze the speed and performance of DC shunt motors under different conditions.	
CEO3	Develop students' ability to test, evaluate, and implement advanced operations in transformers.	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze the critical resistance and critical speed of a DC shunt generator through no-load tests.	4
CO2	Evaluate and plot the external and internal characteristics of a DC shunt generator under varying load conditions	5
CO3	Implement different speed control methods for a DC shunt motor, including armature voltage control and flux control methods.	3
CO4	Determine DC machines' efficiency using direct and indirect methods, including the Brake, Swinburne, and Hopkinson tests.	3
CO5	Evaluate a single-phase transformer's efficiency and voltage regulation through open and short circuit tests and perform parallel operation and back-to-back tests on transformers.	5
CO6	Implement various transformer connections, including Scott Connection, three-phase transformer connections.	3

List of Experiments [Any eight from below list:

1. Determination of critical resistance & critical speed from no load test of a DC shunt generator.
2. Plotting of external and internal characteristics of a DC shunt generator.
3. Speed control of DC shunt motor by armature voltage and flux control methods.
4. Determination of efficiency of DC machine by Brake test (Direct Method)
5. Determination of efficiency of DC machine by Swinburne's Test (Indirect Method)
6. Determination of efficiency of DC machine by Hopkinson's Test. (Regenerative Method)
7. Determination of Efficiency and Voltage Regulation by Open Circuit and Short Circuit test on single phase transformer.
8. Polarity test and Parallel operation of two single-phase transformers.
9. Back-to-back test on two single-phase transformers.
10. Scott Connection of Single-Phase Transformers.
11. Sumpner'sTest on single phase transformer.
12. Three-phase transformer connection
13. Load Test on 1-phase transformer

Subject Code	Name of the Subject	L	T	P	C
	Network Theory Lab	0	0	2	1

	Course Educational Objectives	
CEO1	To provide students with a comprehensive understanding of fundamental network theorems and their application in AC circuits, enabling them to analyze and verify circuit behavior through practical experimentation	
CEO2	To equip students with the skills to analyze and interpret the transient and steady-state responses of DC and AC circuits, fostering their ability to evaluate circuit parameters and understand the impact of different components on overall circuit performance	
CEO3	To develop students' proficiency in analyzing the frequency response of various types of filters and understanding resonance in R-L-C circuits, while also providing hands-on experience in performing spectral analysis of non-sinusoidal waveforms using advanced instrumentation techniques.	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand and verify fundamental network theorems using AC circuits	2
CO2	Analyze the transient response of DC and AC circuits with R-L, R-C, and R-L-C combinations	4
CO3	Determine and evaluate circuit parameters, including Open Circuit, Short Circuit, Hybrid, and Transmission parameters	5
CO4	Assess the frequency response characteristics of various filters, including Low Pass, High Pass, Band Pass, and Band Elimination Filters	4
CO5	Analyze the inductive and capacitive properties of coupled circuits through self-inductance, mutual inductance, and coupling coefficient measurements	4
CO6	Examine resonance phenomena in R-L-C circuits and perform spectral analysis of non-sinusoidal waveforms.	4

List of Experiments [Any eight from below list:]

1. Verification of Network Theorems using AC circuits. (Superposition, Thevenin, Norton, Maximum Power Transfer).
2. Studyof DC and AC Transients for R-L, R-C & R-L-C circuits using storage oscilloscope.
3. Determination of circuit parameters: Open Circuit and Short Circuit parameters.
4. Determination of circuit parameters: Hybrid and Transmission parameters.
5. Frequency response of Low pass and High Pass Filters.
6. Frequency response of Bandpass and Band Elimination Filters.
7. Determination of self-inductance, mutual inductance, and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
8. Studyof resonance in R-L-C series circuit using an oscilloscope.
9. Study of resonance in R-L-C parallel circuit using an oscilloscope.
10. Spectral analysis of a non-sinusoidal waveform.

Subject Code	Name of the Subject	L	T	P	C
	OOPS through JAVA Lab	0	0	2	1

	Course Educational Objectives
CEO1	Build a strong foundation in Java programming, focusing on basic concepts like data types, control structures, and object-oriented principles.
CEO2	Develop the ability to design and debug Java applications using advanced topics like inheritance, polymorphism, and multithreading.
CEO3	Gain proficiency in using advanced Java features like interfaces, inner classes, and generics to create efficient and flexible programs.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand the process of compiling, executing, and troubleshooting Java programs, including the structure and environment of a Java application.	2
CO2	Apply Java data types, variables, and decision control structures to develop and debug simple to moderately complex applications.	3
CO3	Implement loop control structures such as do, while, and for loops to solve iterative problems in Java applications.	3
CO4	Design object-oriented Java applications using principles like classes, objects, data abstraction, and data hiding for modularity and reusability.	6
CO5	Utilize inheritance, polymorphism, threads, and exception handling to create robust and efficient Java applications capable of managing concurrent processes and runtime errors.	3
CO6	Integrate advanced Java concepts such as interfaces, inner classes, wrapper classes, and generics to develop flexible and type-safe programs adhering to best practices.	6

List of Experiments

1. Introduction, Compiling & executing a Java program.
2. Data types & variables, decision control structures: if, nested if, etc.
3. Loop control structures: do, while, for, etc.
4. Classes and objects.
5. Data abstraction & data hiding, inheritance, polymorphism.
6. Threads, exception handlings, and applet programs
7. Interfaces and inner classes, wrapper classes, generics

Subject Code	Name of the Subject	L	T	P	C
	Intermediate Communication skills and Critical thinking (Lab)	0	0	2	1

	Course Educational Objectives	
CEO1	To help students recognize and understand the importance of LSRW (Listening, Speaking, Reading, Writing) skills, laying a foundation for effective communication in various contexts.	
CEO2	To develop students' practical abilities in listening, public speaking, and reading, ensuring they can apply these skills effectively in both professional and personal environments.	
CEO3	To enhance students' critical thinking and writing skills, enabling them to distinguish between professional and general writing and to execute well-reasoned analysis and evaluation in their communication.	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Recognize the importance of LSRW skills	1
CO2	Develop effective listening skills	3
CO3	Demonstrate public speaking skills	3
CO4	Distinguish professional writing from general writing	4
CO5	Develop effective reading skills	3
CO6	Execute critical thinking	5

Comprehensive Listening Activity- Summarizing a Passage Comprehensive Listening Activity- Listening to a short video/ Ted Talk and giving a brief.	(2 hours) (2 hours)
Presentation **Activity- Presenting seminar paper in a team and presenting to the class**	(2 hours)
Individual Oral Presentation **Activity- Preparing a seminar paper individually and presenting.**	**(2 hours)**
Persuasive Speaking Activity- Individual/ Group Debate.	(2 hours)
Situational Interviews Activity- Answering hypothetical question in a mock interview	(2 hours)
Video Resume Activity- Preparing a digital resume	(2 hours)
Professional e-mail Activity- Writing e-mail for professional purpose	(2 hours)

Minutes of the Meeting Activity- Preparing minutes of mock meetings.	**(2 hours)**
Memo Writing Writing Memos for internal organization	**(2 hours)**
Vocabulary Exercise Activity- Playing word games in small groups.	**(2 hours)**
Intermediate Reading Comprehension Activity-Reading an Intermediate level passage/ poems and answer questions.	**(2 hours)**
Preparing a Sales Pitch Activity- Prepare a presentation on any product (real/imaginary) of choice and present a sales pitch	**(2 hours)**

Critical Thinking Activity **(2 hours)**

Activity- critically analysis of Kabuliwala by Rabindranath Tagore OR The Gift of Magi by O Henry

Critical Thinking **(2 hours)**

Activity 2- Critically Analyses Stopping by the Woods in a Snowy Evening by Robert Frost OR Ozymondias by P.B Shelly.

Reference Books

1. An Introduction to Professional English and Soft Skills by B. K. Das et al., Cambridge University Press, 2009.
2. Communicative English for Engineers and Professionals by Nitin Bhatnagar and Mamta Bhatnagar. Published by DK/Pearson, 2010.
3. Practical English usage.MichaelSwan,OUP,1995

R2023
[2023-27]
IV Semester [Second Year]
B. Tech in Electrical Engineering

S.N.	Category	Course Code	Course title	Hours/week			C	CIA	SEE
				L	T	P			
1	PC	23BELPC24001	Electrical Machines - II	3	0	0	3		
2	PC	23BELPC24002	Control Systems	3	0	0	3		
3	PC	23BELPC24003	Electrical Power Transmission and Distribution	3	0	0	3		
4	PC	23BELPC24004	Analog and Digital Circuits	3	0	0	3		
5	ES	23BCSES24001	Data Base Management System	3	0	0	3		
6	HS	23BBSHS24001	English Learning 02	1	0	0	1		
PRACTICAL / SESSIONAL									
7	PC	23BELPC24001	Electrical Machines - II lab	0	0	2	1		
8	PC	23BELPC24002	Control Systems lab	0	0	2	1		
9	ES	23BCSES24001	Data Base Management System Lab	0	0	2	1		
10	PST	23BELPW24001	Mirco Project – I	0	0	2	1		
11	HS	23BBSHS24001	English Lab 02	0	0	2	1		
12	MC	23BMCMC20001	Constitution of India	-	-	-	0		
		23BMCMC20002	Essence of Indian Traditional Knowledge						
			TOTAL	16	0	10	21		
			Cumulative Total	62	4	64	87		

Subject Code	Name of the Subject	L	T	P	C
	ELECTRICAL MACHINES – II	3	0	0	3

	Prerequisites
1	Basic Electrical Engineering: Understanding of fundamental electrical concepts, such as Ohm's law, Kirchhoff's laws, AC/DC circuits, and basic circuit analysis techniques
2	Electromagnetic Field Theory: Knowledge of electromagnetic fields, including electrostatics, magnetostatics, and electromagnetic wave propagation.
3	Introduction to Electrical Engineering: Familiarity with basic electrical engineering concepts and simple circuit theory.

	Course Educational Objectives
CEO1	To provide a comprehensive understanding of Three Phase Synchronous Generators, including their construction, operation, and performance characteristics
CEO2	To analyze the operational principles of salient pole synchronous generators and understand the synchronization and parallel operation of Three Phase A.C. Synchronous Generators.
CEO3	To describe and examine the construction, operation, and applications of Three-Phase Induction Machines, Synchronous Motors, and related electrical machines

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand the construction, operation, and characteristics of Three Phase Synchronous Generators.	2
CO2	Analyze the operation of salient pole synchronous generators and their two-reaction concept.	4
CO3	Describe the construction, principle of operation, and characteristics of Three-Phase Induction Machines.	1
CO4	Examine the operation of Three-Phase Synchronous Motors, including starting methods and steady-state operation.	4
CO5	Illustrate the basic concepts and applications of Three-Phase Induction Generators and wind turbine motors, emphasizing their role in power plants.	3
CO6	Develop a comprehensive understanding of synchronous and induction machines, focusing on their construction, operation, and practical applications.	6

SYLLABUS

UNIT – I	**10 Hrs**
Three Phase Synchronous Generators: Synchronous Generator Construction (both Cylindrical Rotor and Salient Pole type), the Speed of Rotation of a Synchronous Generator, Induced voltage in A.C Machines, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance). **Cylindrical Rotor type Three Phase Synchronous Generators:** The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic), Measuring Synchronous Generator Model Parameters (Open Circuit and Short Circuit Tests and Determination of Synchronous Impedance and Reactance, The Short Circuit Ratio), Voltage Regulation and Speed Regulation. Voltage Regulation by Synchronous Impedance Method.	

UNIT – II	10 Hrs.
Salient Pole type Three Phase Synchronous Generators: Two Reaction Concept, Development of the Equivalent Circuit of a Salient Pole type Three Phase Synchronous Generator (Direct axis and Quadrature axis Reactances, Phasor Diagram for various load power factors,), Torque and Power Equations of Salient Pole Synchronous Generator (Power Angle Equation and Power Angle Characteristic with stator resistance neglected). Slip Test for determination of Direct axis and Quadrature axis Reactances. **Parallel operation of Three Phase A.C. Synchronous Generators:** The Conditions Required for synchronization, The General Procedure for Paralleling Generators.	
UNIT – III	**8 Hrs.**
Three-phase induction machines: Constructional features and types; 3-phase distributed winding production of rotating magnetic field, Principle of Operation, The Effect of Coil Pitch and distribution factor on A.C. Machines, winding factor, Concept of Slip, Slip Speed; Phasor diagram and Development of equivalent circuit and derivation of torque equation; Typical torque-slip characteristic and influence of different parameters on it, No-Load and Blocked Rotor tests, Determination of Parameters, power flow diagram, Losses and Efficiency, Methods of starting and speed control. Cascade control method, Cogging, Crawling.	
UNIT – IV	**6 Hrs.**
Three Phase Synchronous Motors: Basic Principles of Motor operation, Steady State Synchronous Motor operation, Starting of Synchronous Motors, Operation of synchronous motors. Phasor diagrams for normal, under, and overexcited conditions, V and inverted V curves, Synchronous Motor Applications. **Single Phase Induction Motor:** Double field revolving theory, Methods of starting using auxiliary winding, development of equivalent circuit. Types of Single-Phase Induction Motors and their applications include Universal Motor.	
UNIT – V	**6 Hrs.**
Elementary concept of 3 Phase Induction Generator, different types of wind turbine motors, introduction to Servo motors- Stepper motors – introduction to magnetic levitation systems, concept of various electrical pumps. Application of induction motors in power plants.	
Mode of Teaching:	
Text Books: 1. Stephen J. Chapman-'Electric Machinery and Fundamentals'- McGraw HillInternational Edition, (Fourth Edition), 2015. 2. M.G.Say-'Alternating Current Machines', English Language Book Society(ELBS)/ Longman, 5th Edition, Reprinted 1990. 3. P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, JohnWiley and Sons, Wiley India Reprint, 2014.	
Reference Books: 1. D.P. Kothari & I.J. Nagrath - Electric Machines – 4th Edition McGraw Hill – Reprint2015. 2. P S Bimbhra– Electrical Machinery –Khanna Publishers. 3. A Textbook of Electrical Technology - Volume II By BL Theraja	

Subject Code	Name of the Subject	L	T	P	C
	CONTROL SYSTEMS	3	0	0	3

	Prerequisites
1	Basic Electrical Engineering: Understanding fundamental electrical concepts, including circuit analysis, Ohm's law, Kirchhoff's laws, and essential electrical components like resistors, capacitors, and inductors.
2	Mathematics: Proficiency in differential equations, Laplace transforms, and complex numbers, essential for modeling and analyzing control systems.
3	Fundamentals of Electronics: Knowledge of essential electronic devices and circuits, including diodes, transistors, and operational amplifiers, often involved in control systems.

	Course Educational Objectives
CEO1	To provide students with a solid foundation in control system fundamentals, including the development and analysis of mathematical models and feedback mechanisms
CEO2	To equip students to analyze and evaluate time and frequency response characteristics for system stability and control.
CEO3	To enable students to design and implement effective control strategies and gain practical experience with key control system components

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Explain the fundamental concepts of control systems and develop mathematical models of physical systems.	2
CO2	Analyze the time response of first and second-order systems, including steady-state errors and the effects of poles and zeros on system performance.	4
CO3	Evaluate system stability using Hurwitz, Routh, and Root Locus methods and apply these techniques to assess dynamic systems.	5
CO4	Perform frequency response analysis using Bode plots, Nyquist criteria, and related methods to determine system stability in the frequency domain.	4
CO5	Design P, PD, PI, and PID controllers using Zeigler-Nichols tuning methods and understand the operation of control system components like stepper motors and servomotors.	6
CO6	Synthesize knowledge of control systems, including stability analysis and controller design, to effectively manage dynamic systems in practical applications.	6

SYLLABUS

UNIT – I	**10 Hrs**
Basic Concepts of Control Systems, Open Loop and Closed Loop Systems, Servo Mechanism/Tracking System. Mathematical Models of Physical Systems, Differential Equations of Physical Systems, Transfer functions, Block Diagram Algebra, Signal flow Graphs. Feedback characteristics of Control Systems, Effects of Disturbance Signals Using Feedback, and Regenerative Feedback.	
UNIT – II	**10 Hrs.**
Time Response Analysis: Standard Test Signals, Time Response of First Order & Second Order Systems, Steady State Errors and Static Error Constants of Different Types of Systems, Effect of	
Adding Poles/ Zeros on System Response, Design Specification of Second Order System, Performance Indices.	

UNIT – III	8 Hrs.
Concepts of Stability, Necessary Conditions for Stability, Hurwitz Stability Criterion, Routh Stability Criterion, Absolute Stability, Conditional Stability and Relative Stability, Root Locus Concepts, Construction of Root locus, Root Contours. Stability Analysis of Various Dynamic Systems Using Root Locus Plot.	
UNIT – IV	**6 Hrs.**
Frequency Response Analysis: Correlation between Time and Frequency Response, Polar Plots, Mathematical Preliminaries for Stability in Frequency Domain, Bode Plots of Various Dynamic Systems, Determination of Stability Using Bode Plot Methods, Stability Analysis Using Nyquist Stability Criterion, Constant M circles, Constant N-Circles, Nichol's chart	
UNIT – V	**6 Hrs.**
Concept of Proportional, Derivative, and Integral Control actions. Tuning Rules of P, PD, PI, PID Controller Parameters Using Zeigler-Nichol's Method; Design of Real Time P, PI and PID Controllers for Various Dynamic Systems, Control System Components: Stepper motor, AC & DC Servomotor, Synchro's, AC Tachometer.	
Mode of Teaching:	

Text Books:

1. Control Systems Engg. by I.J. Nagrath and M.Gopal, 5th Edition, New Age International Publishers
2. Modern Control Engineering by K. Ogata, 5th edition PHI
3. Automatic Control Systems by Benjamin C. Kuo, 7th Edition, Prentice-Hall India publication.
4. Design of Feedback Control Systems by R.T. Stefani, B. Shahian, C.J. Savator, G.H. Hostetter, Fourth Edition, Oxford University Press.

Reference Books:

1. Control Systems (Principles and Design) by M.Gopal 3rd edition, TMH.
2. Control Systems 2nd edition, kindle edition by A. Anand kumar, PHI.
3. Automatic Control Systems (With MATLAB Programs) by Hasan Saeed, Arihant Publishers.

Subject Code	Name of the Subject	L	T	P	C
	Electrical Power Transmission and Distribution	3	0	0	3

	Prerequisites
1	Basic Electrical Engineering: Understanding of fundamental electrical concepts such as voltage, current, resistance, power, and energy, along with an introduction to AC and DC circuits
2	Electromagnetic Fields: Knowledge of electromagnetic field theory, including concepts like electric and magnetic fields, Gauss's law, Faraday's law, and Ampere's law.
3	Circuit Theory: Familiarity with circuit analysis techniques, including Kirchhoff's laws, network theorems, and the analysis of both linear and non-linear circuits.
4	Mathematics: Proficiency in calculus, linear algebra, and differential equations, as these are essential for understanding and solving complex electrical engineering problems.

	Course Educational Objectives
CEO1	Equip students with the skills to calculate and analyze transmission line constants, considering transposition, skin effect, and proximity effect.
CEO2	Enable students to evaluate and apply key concepts in the performance of transmission and distribution systems.
CEO3	Prepare students to design, construct, and maintain high-voltage power systems, focusing on safety, reliability, and efficiency.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Calculate the magnetic flux density, inductance, and capacitance of transmission lines, including transposition, skin effect, and proximity effect.	3
CO2	Analyze the performance of short, medium, and long transmission lines using ABCD constants, reactive compensation, and wave equations for uniform lines.	4
CO3	Compare different distribution systems and apply Kelvin's Law for voltage drop calculations while designing effective earthing systems.	4
CO4	Examine high-voltage cables' properties, insulation resistance, and capacitance and understand the corona phenomenon.	4
CO5	Demonstrate the construction, testing, commissioning, and maintenance processes for overhead distribution lines, including proper erection and earthing practices.	3
CO6	Integrate transmission and distribution systems knowledge to design and maintain efficient and reliable power systems, ensuring safety and performance.	6

SYLLABUS

UNIT – I	**10 Hrs**
Line Constant Calculations: Magnetic flux Density, Inductors and Inductance Magnetic field Intensity due to long current carrying conductors, Inductance of two-wire transmission line, Flux linkages with one conductor in a group of conductors, Transposition of power lines, Composite Conductors, Inductance of Composite Conductors, Inductance of double circuit three-phase line, Concept of GMD, bundled conductors, Skin and Proximity effect.	
Capacitance of Transmission Lines: Electric Field of a Line of charge, Straight Conductor, The Potential Difference between Two Points due to a line Charge, Two infinite lines of charge, Capacitance of a Two-Wire Line, Capacitance of a Three Phase Line with Unsymmetrical Spacing, Capacitance of a double circuit line, Inductance of three phase un symmetrically spaced transmission, Effect of Earth on the Capacitance of conductors.	

UNIT – II	10 Hrs.

Performance of Lines: Representation of Lines, Short Transmission Lines, The Medium Transmission Lines, The Long Transmission Line: The Long Transmission Line, ABCD constants, Ferranti Effect Hyperbolic Form of The Equations, The Equivalent Circuit of a Long Line, Power Flow Through Transmission Line, Reactive Compensation of Transmission Line. Series and shunt compensation. Wave equation for uniform transmission lines.

Overhead Line Insulators: Insulator Materials, Types of Insulators, Voltage Distribution over Insulator String, Methods of Equalizing the potential. **Mechanical Design of Overhead Transmission Lines:** The catenary curve, Sag Tension calculation, supports at different levels, Stringing chart, sag Template, Equivalent span, Stringing of Conductors, Vibration and Vibration Dampers.

UNIT – III	8 Hrs.

Distribution: Comparison of various Distribution Systems, AC three-phase four-wire Distribution System, Types of Primary Distribution Systems, Types of Secondary Distribution Systems, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Limitations of Kelvin's Law, General Design Considerations.

Power System Earthing: Soil Resistivity, Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages, Design of Earthing Grid.

UNIT – IV	6 Hrs.

Insulated Cables: The Insulation, Extra High Voltages Cable, Insulation Resistance of Cable, Grading of Cables, Capacitance of Single Core Cables, Heating of cables, Current rating of cables, Overhead lines vs. underground Cables, Types of cable

Corona:

Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona.

UNIT – V	6 Hrs.

Construction, Testing, and Commissioning of Overhead Distribution Lines: Introduction, Survey of Overhead lines, Planning of construction work, Points to be considered at the time of the erection of overhead lines, Erection of support, Setting of stays, Fixing of cross-arms and insulators, Conductor erection, Repairing and jointing of conductors, dead-end clamps, positioning of conductors and attachment to insulator, Jumpers, Tee-offs, Right-of-way, Earthing of transmission lines, Guarding of Overhead lines, Testing and Commissioning of overhead distribution lines, Maintenance of overhead lines.

Mode of Teaching:

Text Books:

1. Stevenson, W.D., Power System Analysis, McGraw Hill (2007)
2. Gupta, B.R., Power System Analysis and Design, S. Chand (2009).
3. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw Hill (2007).

Reference Books:

1. Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).
2. Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., a Text Book on Power System Engineering, DhanpatRai (2008).
3. Electrical power systems Ashfaq Hussain CBS Publication 2009

Subject Code	Name of the Subject	L	T	P	C
	ANALOG AND DIGITAL CIRCUITS	3	0	0	3

	Prerequisites
1	Basic Electrical and Electronics Engineering: Understanding fundamental electrical circuits and essential electronic components like diodes and transistors.
2	Mathematics: Proficiency in algebra, calculus, and differential equations for circuit and system modeling.
3	Physics: Knowledge of fundamental physics, including electromagnetism and semiconductor principles.
4	Introduction to Digital Logic Design: Familiarity with basic digital logic concepts, including binary number systems, logic gates, and simple combinational circuits, to ease the transition into more complex digital electronics topics.

	Course Educational Objectives
CEO1	Understand and design analog circuits, including voltage regulators, semiconductor devices, and biasing circuits, focusing on FET and BJT performance.
CEO2	Design and implement circuits using operational amplifiers and IC 555 timers, applying theoretical principles to practical analog and digital applications.
CEO3	Apply concepts in digital electronics, including number systems, Boolean algebra, and sequential circuits, to design and analyze complex digital systems.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Design voltage regulators and analyze the characteristics and applications of various semiconductor devices, including FETs and BJTs.	5
CO2	Apply operational amplifier principles to design and implement basic op-amp applications and IC 555 timer circuits.	3
CO3	Simplify combinational logic circuits using Boolean algebra, SOP and POS forms, and K-map methods for digital circuit design.	4
CO4	Develop sequential circuits bydesigning and converting various flip-flops and constructing excitation tables.	6
CO5	For digital applications, construct counters and shift registers, including UP/DOWN, synchronous, asynchronous, Ring, and Johnson counters.	6
CO6	Integrate analog and digital electronics knowledge to design and analyze comprehensive electronic systems, addressing practical engineering problems.	5

SYLLABUS

UNIT – I	**10 Hrs**
Introduction to analog electronics. Various types of voltage regulators. Zener diode. Series and Shunt Regulator Regulator ICs 78XX, IC 79XX LED ,Schottky diode, Varactor diode Photo diodes, Liquid crystal Displays, Solar cells, Thermistor BJT Biasing DC operating point, BJT characteristics & parameters Different biasing circuits and its design Differential Amplifier, constant current source Current mirror FET and BJT comparison.	
UNIT – II	**10 Hrs.**
Introduction to Operational Amplifiers Block diagram representation, Ideal Op-amp, Equivalent circuit, Open-loop configuration, Transfer characteristics Frequency response. Basic op-amp applications IC 555 Timer,. Astable, and Monostable Multivibrator	

UNIT – III	8 Hrs.
Number Systems and Codes Number system and its conversion Arithmetic operation and different codes in digital system Boolean Algebra and Logic Gates Theorems and Properties of Boolean Algebra, Standard SOP and POS form Reduction of Boolean functions using Algebraic method, K -map method Basic Digital Circuits Combinational Logic circuit Design.	
UNIT – IV	**6 Hrs.**
Design SR, D, Flip Flop Design JK, , T Flip Flop Excitation Table JK Master Slave Flip Flop Flip-flop conversion.	
UNIT – V	**6 Hrs.**
Shift Registers Bidirectional, Universal Shift Register UP/ DOWN Counter (Synchronous and Asynchronous) Ring and Johnson Counter.	

Mode of Teaching:

Text Books:

1. Robert L. Boylestad, Louis Nashelsky, "Electronic devices and circuit Theory", PHI
2. Ramakant A. Gaikwad, "Op-amp and linear Integrated circuits", PHI
3. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill.

Reference Books:

1. Martin s. Roden, Gordon L. Carpenter, William R. Wieserman "Electronic Design-From Concept to Reality", Shroff Publishers and Distributors.
2. D. roy Choudhury, shail B .jain, "Linear integrated Circuits", New age International Publisher
3. Jimmie j. Cathey, "Electronic Devices and Circuits", Schaum's Outline,2nd Ed.
   M. Morris Mano, Digital Design,6th Ed, Pearson .

Subject Code	Name of the Subject	L	T	P	C
	Data Base Management System	3	0	0	3

	Prerequisites
1	Basic Programming Knowledge: Understanding of basic programming concepts and familiarity with at least one programming language (e.g., C, C++, or Java)
2	Introduction to Computer Science: A foundational course in computer science that covers basic concepts of computing, algorithms, and data structures, which are essential for understanding database systems.
3	Mathematics for Computing: A course that covers discrete mathematics, set theory, logic, and algebra, providing the mathematical background needed for relational algebra, calculus, and database design principles

	Course Educational Objectives
CEO1	Provide a foundational understanding of database systems, including their architecture, data models, and advantages over traditional file systems.
CEO2	Equip students with skills to design, normalize, and optimize databases using modeling techniques and SQL.
CEO3	Introduce advanced database topics like transaction processing, concurrency control, and modern database architectures.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand database systems' core concepts and advantages over traditional file systems, including architecture, schemas, and data models.	2
CO2	Analyze the Entity-Relationship model and relational query languages, including SQL and QBE, for effective database design and querying.	4
CO3	Design normalized databases by applying functional dependencies and normalization techniques, ensuring efficient query processing and optimization	6
CO4	Compare different data models and storage strategies, including indexing and file organization techniques, for efficient data management.	4
CO5	Apply concepts of transaction processing, concurrency control, and recovery methods to ensure database integrity and reliability.	3
CO6	Integrate comprehensive knowledge of database systems, covering design, optimization, storage, and transaction management, focusing on foundational and advanced topics.	6

SYLLABUS

UNIT – I	**8 Hrs**
Introduction to database Systems, advantages of database system over traditional file system, Basic concepts & Definitions, Database users, Database Language, Database System Architecture, Schemas, Sub Schemas, & Instances, database constraints, 3-level database architecture, Data Abstraction, Data Independence, Mappings, Structure, Components & functions of DBMS, Data models	
UNIT – II	**8 Hrs.**
Entity relationship model, Components of ER model, Mapping E-R model to Relational schema, Relational Algebra, Tuple & Domain Relational Calculus, Relational Query Languages: SQL and QBE.	

UNIT – III	8 Hrs.
Database Design :-Database development life cycle (DDLC), Automated design tools, Functional dependency and Decomposition, Join strategies, Dependency Preservation & lossless Design, Normalization, Normal forms:1NF, 2NF,3NF, and BCNF, Multi-valued Dependencies, 4NF & 5NF. Query processing and optimization: Evaluation of Relational Algebra Expressions, Query optimization, Query cost estimation.	
UNIT – IV	**8 Hrs.**
Network and Object Oriented Data models, Storage Strategies: Detailed Storage Architecture, Storing Data, Magnetic Disk, RAID, Other Disks, Magnetic Tape, Storage Access, File & Record Organization, File Organizations & Indexes, Order Indices, B+ Tree Index Files, Hashing Data Dictionary.	
UNIT – V	**8 Hrs.**
Transaction processing and concurrency control: Transaction concepts, properties of transaction, concurrency control, locking and Timestamp methods for concurrency control schemes. Database Recovery System, Types of Data Base failure & Types of Database Recovery, Recovery techniques. Fundamental concepts on Object-Oriented Database, Object relational database, distributed database, Parallel Database, introduction to Data warehousing & Data Mining.	
Mode of Teaching:	
Text Books: **1.** Sudarshan, Korth: Database System Concepts, 6th edition, McGraw-Hill Education	
Reference Books: 1. Elmasari&Navathe: Fundamentals of Database System, Pearson Education. 2. Ramakrishnan: Database Management Systems, McGraw-Hill Education. 3. Andrew S. Tanenbaum: Modern Operating Systems, 3rd Edition, Pearson Education. 4. Terry Dawson, Olaf Kirch: Linux Network Administrator's Guide, 3rd Edition O'Reilly	

Subject Code	Name of the Subject	L	T	P	C
	Advanced Communication Skills and Professional Ethics	1	0	0	1

	Prerequisites
1	Basic Communication Skills: Understanding fundamental concepts of effective communication, including listening, speaking, and writing skills
2	English Language Proficiency: Competency in reading, writing, and understanding English at a level sufficient to engage with advanced communication topics
3	Basic Computer Skills: Familiarity with word processing software and internet tools, as these will be used as technological aids in communication.
4	Fundamentals of Academic Writing: Experience with writing academic or professional documents and understanding of citation practices

	Course Educational Objectives	
CEO1	Improve workplace and public speaking by overcoming listening and speaking barriers	
CEO2	Enhance writing skills and apply ethical practices like proper citation and avoiding plagiarism	
CEO3	Use technology to improve communication accuracy and clarity.*	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Identify and address barriers to effective workplace listening, applying strategies to enhance communication	3
CO2	Overcome barriers to public speaking, resulting in more confident and impactful presentations.	2
CO3	Improve professional writing by recognizing and eliminating barriers to achieve clear and effective communication.	3
CO4	Understand professional ethics, including plagiarism avoidance and proper citation techniques.	2
CO5	Utilize technological aids like Grammarly and Turnitin to enhance accuracy and effectiveness in communication.	3
CO6	Integrate advanced listening, speaking, writing skills, professional ethics, and technological tools to enhance overall communication effectiveness.	5

SYLLABUS

UNIT – I	**4 Hrs**
Advance Listening Skills • Barriers to effective listening at the workplace • Overcoming the barriers.	
UNIT – II	**3 Hrs.**
Advance Speaking Skill • Barriers to the public speaking • Overcoming the barriers	
UNIT – III	**3 Hrs.**
Advance Writing Skills • Barriers to professional writing.	
• Overcoming the barriers.	
UNIT – IV	**4 Hrs.**
Professional Ethics • What is Professional ethics, importance • Plagiarism: Definition, Types, How to avoid. • Citation: What, Why	

UNIT – V	4 Hrs.
Technological Aids for Effective Communication • What and why. • Spell check, Grammarly, Quill-bot, Ithenticate, Turnitin	
Mode of Teaching:	
Text Books: **1.** Practical English Usage, MichaelSwan, OUP,1995	
Reference Books: 1. Communication skills by Sanjay Kumar and Pushp Lata, Oxford University Press; Second Edition, 2015. 2. Advanced Communication English by Dr. O.V. Nachmuthu, The Cambridge Publishers; First Edition, 2011. 3. Professional Ethics in Engineering by Dr. C.Senthil Kumar, ARC Publications, 2017.	

Subject Code	Name of the Subject	L	T	P	C
	Electrical Machines – II Lab	0	0	2	1

	Course Educational Objectives
CEO1	Equip students with the knowledge to determine voltage regulation and reactance parameters of synchronous machines for practical applications.
CEO2	Develop students' ability to analyze parallel operation and stability of alternators and synchronous machines.
CEO3	Enable students to assess the performance and control of various induction motors through practical testing and speed control techniques.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Determine the voltage regulation of an alternator using the synchronous impedance and zero power factor (ZPF) methods and evaluate their effectiveness under various load conditions.	3
CO2	Analyze the parallel operation of two alternators, focusing on synchronization, load sharing, and the factors influencing stable operation.	4
CO3	Measure the direct and quadrature axis reactance of a salient pole synchronous machine to assess its impact on machine performance during different operating scenarios.	3
CO4	Examine a synchronous motor's V and inverted V curves to understand the relationship between excitation, load, and motor stability.	4
CO5	Determine a synchronous machine's positive, negative, and zero sequence reactances and utilize these parameters to analyze machine behavior during fault conditions.	3
CO6	Investigate the performance characteristics of various induction motors, including single-phase and three-phase types, by determining efficiency and torque-slip characteristics and applying speed control techniques.	4

List of Experiments [Any eight from the below list:]

1. Determination of the voltage regulation of an alternator by synchronous impedance method and zero power factor (ZPF) method
2. Study of parallel operation of two alternators
3. Measurement of direct and quadrature axis reactance of a salient pole synchronous machine
4. Determination of the V and inverted V curves of a synchronous motor
5. Determination of parameters of synchronous machine
    a. Positive sequence reactance
    b. Negative sequence reactance
    c. Zero sequence reactance
6. Determination of parameter of a single-phase induction motor and study of
    (a) Capacitor start induction motor
    (b) Capacitor start and capacitor run induction motor
    (c) Universal motor
    (d) Shaded pole motor

(e) Repulsion motor

7. Determination of Efficiency, Plotting of Torque-Slip Characteristics of Three Phase Induction motor by Brake Test.
8. Determination of parameters of three-phase induction motor from No load Test and Blocked Rotor Test
9. Speed control of a three-phase induction motor using variable frequency drives Performance of grid-connected induction generator

Subject Code	Name of the Subject	L	T	P	C
	Electrical Machines – II Lab	0	0	2	1

	Course Educational Objectives
CEO1	Equip students to analyze and implement control systems using DC motors and AC servomotors.
CEO2	Enable students to design and apply control systems, including PID control and compensators.
CEO3	Prepare students to interface PLCs with PCs for automation and data acquisition.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze and implement DC motor-driven position control systems.	4
CO2	Evaluate a two-phase AC servomotor's speed-torque characteristics and transfer function.	5
CO3	Design and analyze lag and lead compensators by obtaining their frequency responses.	4
CO4	Apply Proportional, Integral, and Derivative (PID) control techniques to second-order systems.	3
CO5	Develop various control strategies, including PID control, for temperature control systems.	6
CO6	Interface Programmable Logic Controllers (PLCs) with Personal Computers (PCs) for data acquisition applications.	3

List of Experiments [Any eight from the below list:]

1. Study of a dc motor driven position control system
2. Study of speed torque characteristics of two-phase ac servomotor and determination of its transfer function
3. Obtain the frequency response of a lag and lead compensator
4. To observe the time response of a second-order process with P, PI, and PID control and apply PID control to servomotor
5. To study and validate the controllers for a temperature control system
6. To studythe position control system using Synchro's
7. To plot the displacement-voltage characteristics of the given LVDT
8. To studythe characteristics of J-type thermocouples and thermistors
9. Use a strain gauge to plot the curve between the strain applied to a beam and the output voltage
10. To study the interface of PLC with PC for data acquisition applications

Subject Code	Name of the Subject	L	T	P	C
	Database Management Lab	0	0	2	1

	Course Educational Objectives	
CEO1	Equip students with the skills to manage and manipulate databases using SQL	
CEO2	Develop students' ability to design and implement advanced SQL operations and automation	
CEO3	Prepare students to integrate databases with external applications using ODBC, JDBC, and embedded SQL	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Manage SQL syntax for insertion, deletion, updating, and joining tables to handle and manipulate relational databases effectively	3
CO2	Design SQL queries using advanced join statements and the WHERE clause to retrieve and analyze data from multiple tables	6
CO3	Develop stored procedures, functions, and triggers to automate and enhance database operations.	3
CO4	Apply data recovery techniques, including checkpoint strategies, to maintain database integrity and ensure data reliability.	3
CO5	Implement concurrency control mechanisms using lock operations to resolve issues related to simultaneous database access.	3
CO6	Integrate databases with external applications using ODBC, JDBC, and embedded SQL in C/C++, enabling seamless data exchange and manipulation.	5

List of Experiments

1. Use of SQL syntax: insertion, deletion, joins, updating using SQL.
2. Programs on join statements and SQL queries including where clause.
3. Programs on procedures and functions.
4. Programs on database triggers.
5. Programs on packages.
6. Programs on data recovery using check point technique.
7. Concurrency control problem using lock operations.
8. Programs on ODBC using either VC++.
9. Programs on JDBC.
10. Programs on embedded SQL using C / C++ as host language

R2023
[2023-27]

V Semester [Third Year]
B. Tech in Electrical Engineering

S.N.	Category	Course Code	Course title	Hours/week			C	CIA	SEE
				L	T	P			
1	PC	23BELPC35001	Power Electronics	3	0	0	3		
2	PC	23BELPC35002	Microprocessors and Microcontrollers	3	0	0	3		
3	PC	23BELPC35003	Signals & Systems	3	0	0	3		
4	PE	23BELPE3501*	Professional Elective – I	3	0	0	3		
5	OE	23BELOE3501*	Open Elective – I	3	0	0	3		
6	HS	23BMGMG35001	Organizational Behaviour	2	0	0	2		
		23BMGMG35002	Engineering Economics and Costing						
PRACTICAL / SESSIONAL									
7	PC	23BELPC35101	Power Electronics Lab	0	0	2	1		
8	PC	23BELPC35102	Microprocessors and Microcontrollers Lab	0	0	2	1		
9	PC	23BELPC35104	Skill-oriented Lab -1: Solar PV Lab	0	0	2	1		
10	PST	23BELPW35001	Micro Project - II	0	0	2	1		
11	PST	23BELPW35002	Summer Internship-II	0	0	2	1		
			TOTAL	17	0	10	22		
			Cumulative Total	79	4	74	109		

Professional Elective – I		
	Course Code	Course title
1	23BELPE35011	Switch Gear & Protection
2	23BELPE35012	Switched Mode Power Conversion
3	23BELPE35013	Power Systems Deregulation
4	23BELPE35014	Electrical Engineering Materials

Open Elective – I		
	Course Code	Course title
1	23BELOE35011	Renewable Energy Sources
2	23BELOE35012	Computer Networks
3	23BELOE35013	Fundamentals of Robotics
4	23BELOE35014	Marketing research and marketing management

Subject Code	Name of the Subject	L	T	P	C
	POWER ELECTRONICS	3	0	0	3

	Course Educational Objectives
CEO1	To get knowledge about various power electronics devices
CEO2	To study the operation of various converters
CEO3	To analyze the different control circuits

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Illustrate the static and dynamic characteristics of SCR, Power-MOSFET and Power-IGBT.	2
CO2	Analyze the operation of phase-controlled rectifiers.	4
CO3	Analyze the operation of three-phase full–wave converters, AC Voltage Controllers, and Cycloconverters.	4
CO4	Examine the operation and design of different types of DC-DC converters.	4
CO5	Analyze the operation of PWM inverters for voltage control and harmonic mitigation.	4
CO6	Design sinusoidal PWM systems for inverter applications to improve performance.	6

SYLLABUS

UNIT – I	**14Hrs**
Power Semi-Conductor Devices Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics – Turn on and Turn off Methods - Triggering Methods (R, RC and UJT) – Snubber circuit design. Static and Dynamic Characteristics of Power MOSFET and Power IGBT– Gate Driver Circuits for Power MOSFET and IGBT - Numerical problems.	
UNIT – II	**14Hrs**
Single-phase AC-DC Converters Single-phase half-wave controlled rectifiers - R and RL loads with and without freewheeling diode - Single-phase fully controlled mid-point and bridge converter with R load, RL load and RLE load - Continuous and Discontinuous conduction - Effect of source inductance in Single-phase fully controlled bridge rectifier – Expression for output voltages – Single-phase Semi-Converter with R load-RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis – Dual converter and its mode of operation - Numerical Problems.	
UNIT – III	**14 Hrs.**
Three-phase AC-DC Converters & AC – AC Converters Three-phase half-wave Rectifier with R and RL load - Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Harmonic Analysis - Three-phase Dual Converters - Numerical Problems. Single-phase AC-AC power control by phase control with R and RL loads - Expression for rms output voltage – Single-phase step down and step up Cycloconverter - Numerical Problems.	
UNIT – IV	**8 Hrs.**
DC–DC Converters Operation of Basic Chopper – Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage	
equations using volt-sec balance in CCM & DCM – Expressions for output voltage ripple and inductor current ripple – control techniques – Introduction to PWM control -Numerical Problems.	
UNIT – V	

UNIT – V

DC–AC Converters

Introduction - Single-phase half-bridge and full-bridge inverters with R and RL loads – Phase Displacement Control – PWM with bipolar voltage switching, PWM with unipolar voltage switching - Three-phase square wave inverters - 1200 conduction and 1800 conduction modes of operation - Sinusoidal Pulse Width Modulation - Current Source Inverter (CSI) - Numerical Problems.

Mode of Teaching:

Text Books:

1. Power Electronics: Circuits, Devices and Applications by M H Rashid, 3rd Edition, Pearson
2. Power Electronics: By P. C. Sen, Tata McGraw Hill Education, 12th Edition
3. Power Electronics, V R Moorthi, Oxford University Press

Reference Books:

1. Power Electronics Converters, Applications & Design: by N. Mohan, 2nd Edition, John Wiley & Sons
2. Elements Of Power Electronics: Philip T. Krein, Oxford University Press
3. Power Converter Circuits: by W Shepherd and L Zhang, CRC, Taylor and Francis, Special Indian Edition

Subject Code	Name of the Subject	L	T	P	C
	Microprocessors and Microcontrollers	3	0	0	3

	Course Educational Objectives	
CEO1	Provide a solid understanding of microprocessor architecture and operations.	
CEO2	Develop practical skills in programming and interfacing microprocessors and microcontrollers.	
CEO3	Enable students to design and troubleshoot embedded systems using microcontrollers.	
COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Explain the fundamentals of 8-bit microprocessors, including computer organization, buses, ALU, and clock generation, and their connection to I/O devices.	2
CO2	Describe the hardware architecture of 16-bit microprocessors, focusing on 8086, its memory addressing, bus cycles, and system configurations.	2
CO3	Develop assembly language programs for 16-bit microprocessors using the 8086-instruction set.	3
CO4	Interface microprocessors with peripheral devices using components such as the Intel 8255 Programmable Peripheral Interface.	3
CO5	Program 8-bit microcontrollers, particularly the 8051, by understanding their architecture, memory organization, and instruction set for various operations.	3
CO6	Demonstrate a comprehensive understanding of microprocessor and microcontroller systems, encompassing architecture, interfacing, and programming for embedded systems design.	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to 8-bit microprocessor Introduction to microprocessor, computer and its organization, Programming system; Address bus, data bus and control bus, Tristate bus; ALU, clock generation; Connecting Microprocessor to I/O devices; Data transfer schemes; addressing modes, Architectural advancements of microprocessors.	
UNIT – II	**8 Hrs.**
16-bit Microprocessors-H/W Architecture Introductory System design using microprocessors; 8086 – Introduction, Hardware Architecture; External memory addressing; Bus cycles; some important Companion Chips; Maximum mode bus cycle; 8086 system configuration; Memory Interfacing; Minimum mode system configuration, Interrupt processing.	
UNIT – III	**8 Hrs.**
16-bit microprocessor instruction set and assembly language programming: Programmer's model of 8086; operand types, operand addressing; assembler directives, instruction Set-Data transfer group, Arithmetic group, Logical group.	
UNIT – IV	**8 Hrs.**
Microprocessor peripheral interfacing: Introduction; Generation of I/O ports; Programmable Peripheral Interface (PPI)-Intel 8255; Sample-and-Hold Circuit and Multiplexer; Keyboard and Display Interface; Keyboard and Display Controller (8279).	
UNIT – V	**8 Hrs.**

8-bit microcontroller- H/W architecture instruction set and programming:

Introduction to 8051 Micro-Controllers, Architecture; Memory Organization; Special Function register; Port Operation; Memory Interfacing, I/O Interfacing; Programming 8051 resources, interrupts; Programmer's model of 8051; Operand types, Operand addressing; Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions; Programming.

Mode of Teaching:

Text Books:

1. Microprocessor Architecture, Programming and application with 8085, R.S. Gaonkar, PRI Penram International publishing PVT. Ltd., 5th Edition
2. Microprocessors and Interfacing, Programming and Hardware, Douglas V Hall, TMH Publication, 2006.
3. Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevananthan and S.K. Shah, Oxford University Press.
4. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D.M C Kinlay, Pearson Education, Second Edition, 2008.

Reference Books:

1. Microcontrollers: Principles and Application, Ajit Pal, PHI Publication
2. Microprocessors and Microcontrollers Architecture, programming and system design using 8085, 8086, 8051 and 8096, Krishna Kant, PHI Publication, 2007.
3. Advanced Microprocessors and Peripherals, A.K. Ray, K M Bhurchandi, TMH
4. Textbook of Microprocessor and Microcontroller, Thyagarajan, Scitech Publication
5. The 8088 and 8086 Microprocessors Programming, Interfacing, Software, Hardware and Application; by Walter A. Triebel&Avtar Singh ; Pearson India

Subject Code	Name of the Subject	L	T	P	C
	SIGNALS & SYSTEMS	3	0	0	3

	Course Educational Objectives
CEO1	To explain the basics of signals and systems, helping students classify and work with different signals and systems.
CEO2	To help students analyze and perform operations on discrete-time signals, understanding their properties and uses.
CEO3	To enable students to design and analyze discrete-time systems using various techniques like block diagrams, convolution, and Z-transform

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Classify various types of signals and systems	2
CO2	Apply mathematical operations on discrete-time signals	3
CO3	Construct block diagram representations of discrete-time systems	5
CO4	Evaluate the behavior of LTI systems using convolution and correlation	5
CO5	Analyze discrete-time systems using the Z-transform	4
CO6	Demonstrate the relationship between pole-zero locations, stability, and causality	2

SYLLABUS

UNIT – I	**10 Hrs.**
INTRODUCTION: Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude shifting, amplitude-scaling. Problems on classification and characteristics of Signals and Systems. Complex exponential and sinusoidal signals, Singularity functions and related functions: impulse function, step function signum function and ramp function. Analogy between vectors and signals, orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, closed or complete set of orthogonal functions, Orthogonality in complex functions. Related Problems.	
UNIT – II	**8 Hrs.**
DISCRETE TIME SIGNALS: Representation of discrete time signal, Elementary signals, Mathematical Operations on discrete time signals, Classification of discrete time signal- Periodic and Non periodic signal, Even and Odd signal, Energy and Power signal, Causal and Non causal signal.	
UNIT – III	**8 Hrs.**
DISCRETE TIME SYSTEMS: -Block diagram representation, Classification-Static and Dynamic, Time Variant and Time Invariant, Linear and Nonlinear, Stable and Unstable, Causal and Non-causal, FIR and IIR, Recursive and Non-Recursive Interconnection of discrete time system.	
UNIT – IV	**8 Hrs.**
ANALYSIS OF LTI SYSTEM: - LTI System, Convolution, and Properties of convolution, Stability of LTI system, Correlation: -Cross correlation and Auto correlation, Solution to the Difference Equation: -Zero Input and Zero State Response, Impulse Response and Step response	
UNIT – V	**6 Hrs.**
Z-TRANSFORM: - Introduction, Region of Convergence, Properties of Z-Transform-Time Shifting, Differentiation, Time Reversal, Scaling, Parseval's relation. Inverse Z-Transform-Long division method, Partial fraction method. Transfer function and impulse Response, Pole-zero location, Causality and Stability.	

Text Books:

1. Signals, Systems & Communications – B.P. Lathi, BS Publications, 2003.
2. Signals and Systems – A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn, 1997
3. Signals & Systems – Simon Haykin and Van Veen, Wiley, 2ndEdition, 2007
4. Signals and Systems by A. Nagoor Kani, Tata McGraw Hill Publishing Company Ltd.
5. Signals and Systems by P. Ramesh Babu, SCITECH

Reference Books:

1. Linear Systems and Signals by B.P.Lathi, Oxford University Press
2. Signals and Systems by A. Anand Kumar, 3rd Edition PHI Learning Pvt. Ltd.
3. Signals and Systems by A. V. Oppenheim and R. W. Schafer, Pearson Education.

Subject Code	Name of the Subject	L	T	P	C
	SWITCH GEAR & PROTECTION	3	0	0	3

	Course Educational Objectives	
CEO1	To provide students with a deep understanding of the principles, calculations, and operational characteristics of various circuit breakers and protective relays used in power systems.	
CEO2	To equip students with the skills to design, implement, and evaluate protection schemes for critical power system components such as generators, transformers, and grounding systems.	
CEO3	To develop the ability in students to integrate knowledge of power system protection, including overvoltage protection, and apply it to design effective and comprehensive protection schemes	
COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Understand the principles of arc interruption, calculate RRRV, and the operation of different types of circuit breakers.	2
CO2	Understand the construction, operation, and application of various electromagnetic and static relays in power system protection.	2
CO3	Capable of designing protection schemes for generators and transformers, including solving related numerical problems.	3
CO4	Evaluate different neutral grounding methods and understand their effects on power system performance.	5
CO5	Learn to protect power systems against over voltages using appropriate devices and the concepts of insulation coordination.	2
CO6	Integrate knowledge of circuit breakers, relays, grounding, and overvoltage protection to effective protection schemes for electrical power systems.	3

SYLLABUS

UNIT – I	**8 Hrs.**
Circuit Breakers: Elementary principles of arc interruption, Recovery, Restriking Voltage and Recovery voltages. - Restriking Phenomenon, Average and Max. RRRV, Numerical Problems. Current Chopping and Resistance Switching. CB ratings and Specifications: Types and Numerical Problems. –Auto-reclosures. **Description and Operation of following types of circuit breakers:** Minimum Oil Circuit breakers, Air Blast Circuit Breakers, Vacuum and SF6 circuit breakers.	
UNIT – II	**10 Hrs.**
Electromagnetic and Static Relays Principle of Operation and Construction of Attracted armature, Balanced Beam, induction Disc, and Induction Cup relays. Relays Classification: Instantaneous, DMT and IDMT types. Application of relays: Over current/ under voltage relays, Direction relays, Differential Relays and Percentage Differential Relays. Universal torque equation, Distance relays: Impedance, Reactance and Mho and Off-Set Mho relays, Characteristics of Distance Relays and Comparison. Static Relays: Static Relays verses electromagnetic Relays.	

UNIT – III	10 Hrs.
Protection	
Generator Protection: Protection of generators against Stator faults, Rotor faults, and Abnormal Conditions. Restricted Earth fault and Inter-turn fault Protection. Numerical Problems on % Winding Unprotected. Transformer Protection: Percentage Differential Protection, Numerical Problem on Design of CTs Ratio, Buchholtz relay Protection. Feeder and Bus-Bar Protection: Over Current, Carrier Current and Three-Zone distance relay protection using Impedance relays. Translay Relay. Protection of Bus bars – Differential protection	
UNIT – IV	**6 Hrs.**
Neutral Grounding: Grounded and Ungrounded Neutral Systems.- Effects of Ungrounded Neutral on system Performance. Methods of Neutral Grounding: Solid, Resistance, Reactance –Arcing Grounds and Grounding Practices.	
UNIT – V	**6 Hrs.**
Protection against over voltages: Generation of Over Voltages in Power Systems. Protection against Lightning over Voltages – Valve type and Zinc-Oxide Lighting Arresters. Insulation and Coordination -BIL, Impulse Ratio, Standard Impulse Test Wave, Volt-Time Characteristics and Insulation Co-ordination	
Mode of Teaching:	
Text Books: 1. Sunil S Rao "Switchgear Protection & Power Systems", Khanna Publishers 2. Badari Ram & D.N Viswakarma "Power System Protection and Switchgear", TMH publications	
Reference Book: *1.* Paithankar and S.R.Bhide, "Fundamentals of Power System Protection", PHI, 2003. *2.* T S Madhav Rao, "Power System Protection : Static Relays", Tata McGraw-Hill, 2nd edition *3.* C R Mason, "Art & Science of Protective Relaying", Wiley Eastern Ltd. *4.* Cl Wadhwa, "Electrical Power Systems", New Age international (P) Limited, Publishers, 3rd editon "	

Subject Code	Name of the Subject	L	T	P	C
	SWITCHED MODE POWER CONVERSION	3	0	0	3

	Course Educational Objectives
CEO1	To enable students to understand and optimize the performance of non-isolated and isolated DC-DC converters
CEO2	To provide students with the skills to design and apply resonant converters for efficient power conversion
CEO3	To develop students' ability to model and design control schemes and magnetic components for stable switch-mode power converters

COs	***Upon successful completion of this course, students should be able to***	**BTL**
CO1	Analyze non-isolated DC-DC converters, including their operation in continuous and discontinuous modes with non-ideal components	4
CO2	Evaluate the performance of isolated switched mode converters across various configurations	5
CO3	Apply resonant converter principles to assess series and parallel circuits with zero current and zero voltage switching	3
CO4	Design control schemes and magnetic components, ensuring stability in converter operation	6
CO5	Model buck and boost converters using large and small signal techniques for effective controller design	6
CO6	Optimize the overall design and functionality of switch-mode power converters and their control systems	6

SYLLABUS

UNIT – I	**8 Hrs**
Non-Isolated Switch Mode Converters Control of DC-DC converters: Buck converters - Boost converters - Buck-Boost converter - CUK Converter - continuous and discontinuous operation - Converter realization with non-ideal components.	
UNIT – II	**8 Hrs**
Isolated Switched Mode Converters Forwarded converter - flyback converter - push-pull converter - half-bridge converter - full bridge converter.	
UNIT – III	**8 Hrs.**
Resonant Converters Basic resonant circuit concepts - series resonant circuits - parallel resonant circuits - zero current switching quasi-resonant buck converter - zero current switching quasi-resonant boost converter - zero voltage switching quasi-resonant buck converter - zero voltage switching quasi-resonant boost converter.	
UNIT – IV	**6 Hrs.**
Control Schemes of Converters and Magnetic Design Voltage mode control - Current mode control - Current control mode instability. **Magnetic Design:** Transformer design - inductor and capacitor design.	
UNIT – V	**10 Hrs.**

Modelling of Converters and Controller Design Based on Linearization:

Formulation of large signal models for buck and boost converters using state space analysis- derivation of averaged large signal model using circuit averaging method-small signal model derivation- average switch modelling technique to obtain small signal models of buck and boost converters- Transfer function of converters-Controller design based on linearization.

Mode of Teaching:

Text Books:

1. Fundamentals of Power Electronics- Erickson - Robert W. - Maksimovic - Dragan - Springer - 2011.
2. Power switching converters- Simon Ang - Alejandro Oliva - CRC Press - 2010.
3. Power Electronics: Essentials & Applications- L. Umanand, S.P. Bhat, John Wiley & Sons Australia, 1992.

Reference Books:

1. Switching Power Supply Design- Abraham I. Pressman - McGraw-Hill Ryerson - Limited - 1991.
2. Power Electronics: converters Applications & Design – Mohan - Undeland - Robbins- Wiley publications.
3. Design of Magnetic Components for Switched Mode Power Converters- Z Umanand - S.P. Bhat - John Wiley & Sons Australia - 1992.
4. Elements of Power Electronics – Philip T. Krein - Oxford University press - 2014.

Subject Code	Name of the Subject	L	T	P	C
	POWER SYSTEM DEREGULATION	3	0	0	3

	Course Educational Objectives	
CEO1	Provide students with an understanding of power system deregulation and its impact on system reliability.	
CEO2	Equip students to analyze and evaluate electricity sector models, market frameworks, and pricing mechanisms.	
CEO3	Develop students' skills in managing transmission networks, congestion, and ancillary services in deregulated markets.	
COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Analyze the need for deregulation and various market structures in the power sector.	4
CO2	Evaluate different electricity sector ownership models and compute Available Transfer Capability (ATC).	5
CO3	Assess bilateral and pool market frameworks, including LMP-based markets and auction models.	5
CO4	Investigate the effects of transmission network congestion and methods for congestion management.	4
CO5	Explore the role and management of ancillary services in ensuring system security in deregulated markets.	3
CO6	Synthesize knowledge of power system deregulation to address real-world challenges.	6

SYLLABUS

UNIT – I	**8 Hrs**
Need and conditions for deregulation. Introduction of Market structure - Market Architecture - Spot market - forward markets and settlements. Review of Concepts marginal cost of generation - least-cost operation - incremental cost of generation. Power System Operation - Power Exchange.	
UNIT – II	**8 Hrs**
Electricity sector structures and Ownership /management - the forms of Ownership and management. Different structure model like Monopoly model - Purchasing agency model - wholesale competition model - Retail competition model - Definition of Available Transfer Capability (ATC) - computation of ATC.	
UNIT – III	**8 Hrs.**
Framework and methods for the analysis of Bilateral and pool markets - LMP based markets. Auction models and price formation - price based unit commitment - country practices.	
UNIT – IV	**8 Hrs.**
Transmission network and market power. Power wheeling transactions and marginal costing - transmission costing. Congestion management methods- market splitting - counter-trading; Effect of congestion on LMPs- country practices.	
UNIT – V	**8 Hrs.**
Ancillary Services and System Security in Deregulation. Classifications and definitions - AS management in various markets- country practices. Technical - economic - & regulatory issues involved in the deregulation of the power industry.	

Text Books:

1. Power System Economics: Designing markets for electricity - Steven Stoft - wiley publishers - 2002.
2. Operation of restructured power systems - K. Bhattacharya - M.H.J. Bollen and J.E. Daalder – Springer - 2012.

Reference Books:

1. Power generation - operation and control - -J. Wood and B. F. Wollenberg - Wiley – 1998.
2. Market operations in electric power systems - M. Shahidehpour - H. Yaminand Z. Li – Wiley -2003.
3. Fundamentals of power system economics - S. Kirschen and G. Strbac - Wiley - 2nd edition - 2018.
4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau - IEEE Press series on Power Engineering.
5. "Competition and Choice in Electricity" by Sally Hunt and Graham Shuttleworth - Wiley publishers - 1997.

Subject Code	Name of the Subject	L	T	P	C
	Electrical Engineering Materials	3	0	0	3

	Course Educational Objectives
CEO1	Provide students with a strong understanding of the fundamental properties of materials used in electrical engineering for various applications.
CEO2	Equip students with knowledge of semiconductor and magnetic materials and their applications in electronic components.
CEO3	Develop students' ability to apply insulating and dielectric materials to optimize electrical systems for better performance and reliability.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Analyze various conductors' electrical and mechanical properties and their applications in electrical systems.	4
CO2	Understand the properties of semiconductor materials and their applications in electronic devices.	2
CO3	Distinguish between different types of magnetic materials and their applications in electrical components.	4
CO4	Classify insulators based on their properties and applications in electrical systems.	4
CO5	Explore the properties and applications of various insulating materials in electrical systems.	2
CO6	Integrate knowledge of material properties to enhance the performance and reliability of electrical systems and components.	6

SYLLABUS

UNIT – I	**10 Hrs**
Conductors-electrical properties – resistivity – conductivity - temp. Coefficient-dielectric strength, Mechanical properties-ductility, malleability, tensile strength-properties of silver, copper, Aluminium, and alloys(brass, bronze)-applications - Properties of High resistivity materials temperature co-efficient, high melting point, no tendency for oxidization, ductility - high mechanical strength – Tungsten – Carbon - Mercury – Nichrome – Eureka – Constantan – Platinum - applications - Materials used for heavy-duty contacts-silver copper - copper cadmium. Trade names of commonly used conductors-ACSR, AAA etc	
UNIT – II	**10 Hrs**
Semiconductors-general properties of semi conducting materials-Energy band diagram-covalent bond intrinsic and extrinsic semi-conductor- P and N type semi conducting materials-majority and minority carriers-PN junction-applications -thermistors, photo conductive cells-photo voltaic cells-varistors-LEDLDR-Strain gauge- solar cells - components like diode – transistor – IC.	
UNIT – III	**8 Hrs.**
Magnetic materials-General terms- permeability – absolute & relative permeability - flux, flux density, BH curve-curie point-classification- Dia-para - ferromagnetic materials - examples-applications - magnetostriction-soft and hard magnetic materials, properties of - iron – silicon - CRGO – permalloy - ferrites-applications-components like inductors - transformers	
UNIT – IV	**6 Hrs.**
Insulators-properties – visual – electrical – mechanical- thermal - chemical properties - Classification based on operating temperature as per IS. Properties and application of fibrous material-impregnated fibrous-bitumen –	

UNIT – V	6 Hrs.
wax-insulating liquid-enamel-varnish-ceramics-mica-asbestos-glass-rubber-synthetic resin-thermo-plast resin-Polyethylene-Teflon-PVC-Gas Insulating materials- air-Nitrogen-SF6 – Di-electric -materials - Polarization-applications-capacitors.	
Mode of Teaching:	
Text Books: 1. P L Kapoor. A Textbook Of Electrical And Electronics Engineering Materials: Khanna publishers. 2. BASAK T K. Electrical engineering materials: Newage science. 3. S K BHATTACHARYA. Electrical and Electronic Engineering Materials: Khanna Publishers	
Reference Books: 1. Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi. 2. Electrical Properties of Materials, 8th Edition by Solymar, L, Oxford University PressNew Delhi.	

Subject Code	Name of the Subject	L	T	P	C
	RENEWABLE ENERGY SOURCES	3	0	0	3

	Course Educational Objectives
CEO1	Understand the impacts of energy sources and the need for renewable energy.
CEO2	Learn the principles and applications of renewable energy technologies.
CEO3	Develop the ability to design sustainable energy solutions using various energy systems.

COs	***Upon successful completion of this course, students should be able to***	**BTL**
CO1	Analyze the environmental impacts of conventional energy sources based on seasonal variations, availability, and features.	4
CO2	Understand the operating principles, design, and applications of solar photovoltaic and thermal systems.	2
CO3	Evaluate wind energy conversion systems, focusing on turbine types, aerodynamic principles, and control systems.	5
CO4	Assess biomass conversion technologies and geothermal energy sources.	5
CO5	Understand the principles and conversion technologies of ocean, wave, and tidal energy.	2
CO6	Integrate knowledge of renewable, chemical, and hybrid energy sources to develop sustainable energy solutions.	6

SYLLABUS

UNIT – I	**10 Hrs.**

Introduction:

Conventional energy Sources and its Impacts, Non-conventional energy– seasonal variations and availability, Renewable energy – sources and features, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of these energy sources, Distributed energy systems and its importance,

Solar Energy:

Solar photovoltaic system-Operating principle, Photovoltaic cell concepts, Cell, module, array, Applications-Battery charging, Pumping, Lighting, Peltier cooling. Modeling of PV cell, Solar Thermal system- Solar collectors, Types and performance characteristics, Applications- Solar water heating systems (active & passive), Solar space heating & cooling systems, Solar desalination systems.

UNIT – II	**8 Hrs.**

Wind Energy:

Wind energy, Wind energy conversion; Wind power density, efficiency limit for wind energy conversion, types of wind turbine converters, aerodynamics of wind rotors, wind turbine control systems; conversion to electrical power, Applications &Characteristics of wind power plant

UNIT – III	**8 Hrs.**

Biomass and Geothermal Energy:

Biomass: Introduction - Biomass conversion technologies - Photosynthesis, factors affecting Bio digestion - classification of biogas plants - Types of biogas plants - selection of site for a biogas plant

Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems.

UNIT – IV	6 Hrs.
Energy From Oceans, Waves & Tides: Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India. Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices. Tides: Basic principle of Tide Energy -Components of Tidal Energy.	
UNIT – V	**8 hrs.**
Chemical Energy Sources: Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications. Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, basics of electric and hybrid electric vehicles.	
Mode of Teaching:	
Text Books: 1. G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011. 2. John Twidell & Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013. 3. *D.P.Kothari, K.C.Singal, RakeshRajan,"Renewable Energy Sources and Emerging Technologies", PHI Second Edition*	
Reference Books: 1. S.P.Sukhatme & J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011. 2. John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013. 3. Shoba Nath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.	

Subject Code	Name of the Subject	L	T	P	C
	COMPUTER NETWORKS	3	0	0	3

	Course Educational Objectives
CEO1	Understand the architecture and function of computer networks, focusing on TCP/IP and OSI models.
CEO2	Analyze and evaluate networking protocols and technologies to solve complex problems.
CEO3	Apply advanced networking concepts to real-world scenarios and emerging technologies.

COs	***Upon successful completion of this course, students should be able to***	**BTL**
CO1	Understand the fundamental concepts of computer networks, including network types, reference models, and Internet architecture.	2
CO2	Analyze the design issues and protocols of the Data Link Layer, focusing on error detection, correction, and multiple access methods.	4
CO3	Examine the Network Layer's design issues, routing algorithms, and IP addressing techniques.	4
CO4	Evaluate the services and protocols the Transport Layer provides, including UDP and TCP.	5
CO5	Explore the Application Layer protocols and services, including the client-server model and security algorithms.	4
CO6	Integrate knowledge of network layers to solve real-world networking challenges	6

SYLLABUS

UNIT – I	**8 Hrs**
Introduction: Network, Uses of Networks, Types of Networks, Reference Models: TCP/IP Model, The OSI Model, Comparison of the OSI and TCP/IP reference model. Architecture of Internet. Physical Layer: Guided transmission media, Wireless transmission media, Switching	
UNIT – II	**8 Hrs**
Data Link Layer - Design issues, Error Detection & Correction, Elementary Data Link Layer Protocols, Sliding window protocols Multiple Access Protocols - ALOHA, CSMA,CSMA/CD, CSMA/CA, Collision free protocols, Ethernet- Physical Layer, Ethernet Mac Sub layer, Data link layer switching: Use of bridges, learning bridges, spanning tree bridges, repeaters, hubs, bridges, switches, routers and gateways.	
UNIT – III	**10 Hrs.**
Network Layer: Network Layer Design issues, store and forward packet switching connection less and connection oriented networks-routing algorithms-optimality principle, shortest path, flooding, Distance Vector Routing, Count to Infinity Problem, Link State Routing, Path Vector Routing, Hierarchical Routing; Congestion control algorithms, IP addresses, CIDR, Subnetting, SuperNetting, IPv4, Packet Fragmentation, IPv6 Protocol, Transition from IPv4 to IPv6, ARP, RARP.	
UNIT – IV	**8 Hrs.**
Transport Layer: Services provided to the upper layers elements of transport protocol addressing connection establishment, Connection release, Error Control & Flow Control, Crash Recovery. The Internet Transport Protocols: UDP, Introduction to TCP, The TCP Service Model, The TCP Segment Header, The Connection Establishment, The TCP Connection Release, The TCP Sliding Window, The TCP Congestion Control Algorithm.	
UNIT – V	**6 Hrs.**

Application Layer- Introduction, providing services, Applications layer paradigms: Client server model, HTTP, E-mail, WWW, TELNET, DNS; RSA algorithm,
Mode of Teaching:
Text Books: **1.** Computer Networks - Andrew S Tanenbaum, 4th Edition, Pearson Education. **2.** Data Communications and Networking - Behrouz A. Forouzan, Fifth Edition TMH, 2013.
Reference Books: **1.** An Engineering Approach to Computer Networks - S. Keshav, 2nd Edition, Pearson Education. **2.** Understanding communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning. **3.** Computer Networking: ATop-Down Approach Featuring the Internet, James F. Kurose, K. W. Ross, 3rd Edition, Pearson Education.

Subject Code	Name of the Subject	L	T	P	C
	Fundamentals of Robotics	3	0	0	3

	Course Educational Objectives
CEO1	Provide a foundational understanding of robotics principles and their societal impact
CEO2	Equip students with skills to analyze and design robotic systems and controls
CEO3	Explore and apply robotics in diverse real-world applications

COs	***Upon successful completion of this course, students should be able to***	**BTL**
CO1	Understand the fundamental concepts and history of robotics, including laws, components, classifications, and social impact	2
CO2	Describe the anatomy, configurations, and kinematics of robots, including degrees of freedom and motion analysis.	2
CO3	Analyze different robot drive systems and end effectors, along with robot control types.	4
CO4	Apply path planning techniques using joint and Cartesian space methods for robotic motion.	3
CO5	Identify various applications of robotics across different sectors, including material handling, medical, and unmanned vehicles.	1
CO6	Comprehend the principles, design, control, and applications of robotics in diverse environments.	2

SYLLABUS

UNIT – I	**8 Hrs**
Introduction To Robotics: Introduction to Robotics and Automation, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots.	
UNIT – II	**8 Hrs**
Robot Anatomy And Motion Analysis: Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix.	
UNIT – III	**10 Hrs.**
Robot Drives And End Effectors: Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.	
UNIT – IV	**6 Hrs.**
Path Planning: Definition-Joint space technique, Use of P-degree polynomial-Cubic, polynomial- Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning.	

UNIT – V	8 Hrs.

Robotics Applications:

Material Handling: pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles: ground, Ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Robots, Autonomous robots, and Swarm robots

Text Books:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.
2. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, Special Edition, (2012).
3. Ganesh S Hegde, “A textbook on Industrial Robotics”, University science press, 3rdedition, 2017.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence",McGraw Hill, 1987.

Subject Code	Name of the Subject	L	T	P	C
	MARKETING RESEARCH AND MARKETING MANAGEMENT	3	0	0	3

	Course Educational Objectives
CEO1	Understand core marketing concepts and how external factors influence marketing strategies.
CEO2	Apply product management, pricing, promotion, and distribution strategies in marketing.
CEO3	Develop skills in conducting marketing research and using data analysis for Internet and B2B marketing.

COs	***Upon successful completion of this course, students should be able to***	**BTL**
CO1	Understand core marketing concepts and the influence of macro-environmental factors on marketing strategies.	2
CO2	Apply product management strategies, including the product life cycle, new product development, branding, and packaging decisions.	3
CO3	Utilize pricing strategies, promotional techniques, and distribution methods in marketing communications.	3
CO4	Design marketing research, employ various techniques, and comprehend the scope and limitations of marketing research.	6
CO5	Employstatistical tools for data analysis in marketing research and apply them to internet marketing strategies.	3
CO6	Formulate effective B2B marketing strategies, understanding the organizational buying process and market potential.	6

SYLLABUS

UNIT – I	**8 Hrs**

Marketing Concepts

Marketing Concepts and Applications: Introduction to Marketing & Core Concepts, Marketing of Services, Importance of marketing in service sector. Marketing Planning & Environment: Elements of Marketing Mix, Analyzing needs & trends in Environment - Macro, Economic, Political, Technical & Social Understanding the consumer: Determinants of consumer behaviour, Factors influencing consumer behaviour. Market Segmentation: Meaning & Concept, Basis of segmentation, selection of segments, Market Segmentation strategies, Target Marketing, Product Positioning.

UNIT – II	**8 Hrs**

Product Decisions

Product Management: Product Life cycle concept, New Product development & strategy, Stages in New Product development, Product decision and strategies, Branding & packaging Price, Place and Promotion Decisions

Pricing, Promotion and Distribution Strategy: Policies & Practices – Pricing Methods & Price determination Policies. Marketing Communication – The promotion mix, Advertising & Publicity, 5 M's of Advertising Management. Marketing Channels, Retailing, Marketing Communication, Advertising.

UNIT – III	**8 Hrs.**

Marketing Research

Marketing Research: Introduction, Type of Market Research, Scope, Objectives & Limitations Marketing Research Techniques, Survey Questionnaire design & drafting, Pricing Research, Media Research, Qualitative Research.

UNIT – IV	8 Hrs.

Marketing Research & Data Analysis

Marketing Research & Data Analysis: Use of various statistical tools – Descriptive & Inference Statistics, Statistical Hypothesis Testing, Multivariate Analysis - Discriminated Analysis, Cluster Analysis, Segmenting and Positioning, Factor Analysis.

Internet Marketing: Introduction to Internet Marketing. Mapping fundamental concepts of Marketing (7Ps, STP); Strategy and Planning for Internet Marketing.

UNIT – V	8 Hrs.

B2B Marketing

Business to Business Marketing: Fundamental of business markets. Organizational buying process. Business buyer needs. Market and sales potential. Product in business markets. Price in business markets. Place in business markets. Promotion in business markets. Relationship, networks and customer relationship management. Business to Business marketing strategy. Contemporary issues: Contemporary topics in marketing

Text Books:

1. Marketing Management (2019), Philip Kotler & Keller Kevin,4th edition, Pearson education
2. Marketing Management (2019), Deepak, R. Kanthiah Alias, and S. Jeyakumar, Edu creation Publishing
3. Marketing Management: A relationship approach (2019), Hollensen, S, Pearson Education.
4. Marketing research: An applied approach (2019), Malhotra, N. K., Nunan, D., & Birks, D. F. Pearson Education Limited.

Reference Books:

1. Marketing research: Text and cases (2020), Nargundkar, R, McGraw-Hill Education.
2. Marketing management: A cultural perspective (2020), Visconti, L. M., Peñaloza, L., & Toulouse, N.(Eds.) Routledge.

R2023
[2023-27]

VI Semester [Third Year]
B. Tech in Electrical Engineering

S.N.	Category	Course Code	Course title	Hours/week			C	CIA	SEE
				L	T	P			
1	PC	23BELPC36001	Electrical and Electronics Measurements	3	0	0	3		
2	PC	23BELPC36002	Power System Operation and Control	3	0	0	3		
3	PC	23BELPC36003	PLC & SCADA	3	0	0	3		
4	PE	23BELPE3601*	Professional Elective – II	3	0	0	3		
5	OE	23BELOE3601*	Open Elective – II	3	0	0	3		
6	HS	23BMGMG35001	Organizational Behaviour	2	0	0	2		
		23BMGMG35002	Engineering Economics and Costing						
PRACTICAL / SESSIONAL									
7	PC	23BELPC36104	Skill oriented Lab – 2: IOT & Data Analytics Lab	0	0	2	1		
8	PC	23BELPC36105	Skill oriented Lab – 3: EV Lab	0	0	2	1		
9	PST	23BELPW36001	Mini Project	0	0	2	1		
			TOTAL	17	0	6	20		
			Cumulative Total	96	4	80	129		

Professional Elective – II				**Open Elective – II**		
	Course Code	Course title			Course Code	Course title
1	23BELPE36011	Hybrid Electric Vehicles		1	23BELOE36011	Internet of Things
2	23BELPE36012	Electrical Standards & Electricity regulations		2	23BELOE36012	MEAN Stack Technologies
3	23BELPE36013	Special Electrical Machines		3	23BELOE36013	Computer Architecture and Organization
4	23BELPE36014	HVDC Transmission		4	23BELOE36014	Linear IC Applications

Subject Code	Name of the Subject	L	T	P	C
	ELECTRICAL AND ELECTRONICS MEASUREMENTS	3	0	0	3

	Course Educational Objectives
CEO1	Equip students with knowledge of measurement principles and error analysis.
CEO2	Develop students' ability to operate and analyze electrical measuring instruments and transducers.
CEO3	Enable students to apply advanced techniques for measuring resistance, inductance, and capacitance.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Understand the concepts of measurement and error, including accuracy, precision, and measurement standards.	2
CO2	Explain the principles, construction, and operation of various measuring instruments.	2
CO3	Demonstrate the ability to measure resistance, inductance, and capacitance using various methods.	3
CO4	Describe the operation and application of different transducers, the screening of bridge components, and the use of the Wagnor Earthing Device.	1
CO5	Analyze the construction, theory, and operation of galvanometers and potentiometers, including both DC and AC types.	4
CO6	Apply comprehensive knowledge of electrical measuring instruments, transducers, and measurement techniques to ensure accurate data collection in engineering applications.	3

SYLLABUS

UNIT – I	**10 Hrs**
Measurement and Error: Definition, Accuracy and Precision, Significant Figures, Types of Errors, Standards of Measurement: Classification of Standards, Electrical Standards, IEEE Standards Types of measuring instrument: (Ammeter and Voltmeter: Derivation for Deflecting Torque of; PMMC, MI (attraction and repulsion types), Electro Dynamometer and Induction type Ammeters and Voltmeters. Energy meters and wattmeter, Construction, Theory and Principle of operation of Electro-Dynamometer and Induction type wattmeter, compensation, creep, error, testing, Single Phase and Poly-phase Induction type Watt-hour meters. Frequency Meters: Vibrating reed type, electrical resonance type, Power Factor Meters.	
UNIT – II	**10 Hrs**
Measurement of Resistance, Inductance and Capacitance: Resistance: Measurement of Low Resistance by Kelvin's Double Bridge, Measurement of Medium Resistance, Measurement of High Resistance, Measurement of Resistance of Insulating Materials, Portable Resistance Testing set (Meg ohmmeter), Measurement of Insulation Resistance when Power is ON, Measurement of Resistance of Earth Connections. Inductance: Measurement of Self Inductance by Ammeter and Voltmeter, and AC Bridges(Maxwell's, Hay's, & Anderson Bridge), Measurement of Mutual Inductance by Felici's Method, and as Self Inductance. Capacitance: Measurement of Capacitance by Ammeter and Voltmeter, and AC Bridges (Owen's, Schering & Wien's Bridge),	
UNIT – III	**6 Hrs.**
Screening of Bridge Components and Wagnor Earthing Device, Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive	
Transducers, Peizo-Electric transducers, Optical Transducer, Torque meters, inductive torque transducers, electric tachometers, photo-electric tachometers, Hall Effect Transducer.	

UNIT – IV	6 Hrs.
Galvanometer: Construction, Theory and Principle of operation of D'Arsonval, Vibration (Moving Magnet & Moving Coil types), and Ballistic Galvanometer, Influence of Resistance on Damping, Logarithmic decrement, Calibration of Galvanometers, Galvanometer Constants, Measurement of Flux and Magnetic Field by using Galvanometers, Potentiometer: Construction, Theory and Principle of operation of DC Potentiometers (Crompton, Vernier, Constant Resistance, & Deflection Potentiometer),and AC Potentiometers (Drysdale-Tinsley & Gall-Tinsley Potentiometer)	
UNIT – V	**8 Hrs.**
Current Transformer and Potential Transformer : Construction, Theory, Characteristics and Testing of CTs and PTs, Electronic Instruments for Measuring Basic Parameters: Amplified DC Meters, AC Voltmeters using Rectifiers, True RMS Voltmeter, Considerations for choosing an Analog Voltmeter, Digital Voltmeters (Block Diagrams only), Q-meter, Oscilloscope: Block Diagrams, Delay Line, Multiple Trace, Oscilloscope Probes, Oscilloscope Techniques, Introduction to Analog and Digital Storage Oscilloscopes, Measurement of Frequency, Phase Angle, and Time Delay using Oscilloscope.	
Mode of Teaching: Chalk& Board/ PPT/Video Lectures	
Text Books: 1. Electrical Measurements and Measuring Instruments – Golding &Widdis – 5th Edition, Reem Publication. 2. Modern Electronic Instrumentation and Measurement Techniques – Helfrick& Cooper – Pearson Education.	
Reference Books: 1. A Course in Electrical and Electronic Measurements and Instrumentation – A K Sawhney – DhanpatRai& Co. 2. Electronic Instrumentation – H C Kalsi – 2nd Edition, Tata McGraw Hill. 3. Electronic Measurement and Instrumentation – Oliver & Cage – Tata McGraw Hill.	

Subject Code	Name of the Subject	L	T	P	C
	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3

	Course Educational Objectives
CEO1	Understand fundamental power system concepts, including power calculations and system analysis using diagrams.
CEO2	Develop skills to analyze and solve power system network problems using admittance models and power-flow techniques.
CEO3	Apply principles of economic operation, load frequency control, and stability to design and operate efficient power systems.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Understand the fundamentals of power systems, including power calculations, per-unit quantities, and diagrammatic representations.	2
CO2	Analyze admittance models and perform network calculations, including Y-bus matrix construction and modification.	4
CO3	Apply power-flow solution techniques for system design and operational studies.	3
CO4	Examine the principles of economic operation and load distribution within power systems.	4
CO5	Develop an understanding of load frequency control in single and multi-area systems.	6
CO6	Integrate power system stability, economical operation, and control techniques to ensure reliable and efficient power system operation.	5

SYLLABUS

UNIT – I	**12 Hrs**
Fundamentals of Power System: Introduction, Single Subscript Notation, Double Subscript Notation, Power in Single Phase AC Circuit, Complex Power, The Power Triangle, Direction of Power Flow, Voltage and Current in Balanced Three Phase Circuits, Power in Balanced Three Phase Circuits, Per- Unit Quantities, Changing the Base in Per- Unit Quantities, Node Equations, The Single Line or One Line Diagram, Impedance and Reactance Diagrams. **The Admittance Models & Network Calculations**: Branch and Node Admittances, Mutually Coupled Branches in Ybus, an Equivalent Admittance Network, Modification of Ybus, the Network Incidence Matrix and Ybus. **Power Flow Solutions:** The Power-Flow Problem, the Gauss-Seidal Method, the Newton-Raphson Method, the Newton-Raphson Method, Power-Flow Studies in System Design and Operation, Regulating Transformers, the Decoupled Method.	
UNIT – II	**6 Hrs.**
Economic Operation of Power System: Distribution of Load between Units within a Plant, Distribution of Load between Plants, The Transmission-Loss Equation, An interpretation of Transformation C, Classical Economic Dispatch with Losses, Automatic Generation Control, Unit Commitment, Solving the Unit Commitment Problems.	
UNIT – III	**6 Hrs.**
Load Frequency Control, Control Area Concept: Automatic Load-Frequency Control of Single Area Systems: Speed-Governing System, Hydraulic Valve Actuator, Turbine-Generator Response, Static Performance of Speed Governor, Closing the ALFC Loop, Concept of Control Area, Static	
Response of Primary ALFC Loop, Dynamic Response of ALFC Loop, Physical Interpretation of Results, The Secondary ("Reset") ALFC Loop, Economic Dispatch Control.	

UNIT – IV	8 Hrs.
Two Area Systems: ALFC of Multi-Control-Area Systems (Pool Operation): The Two Area Systems, Modelling the Tie-Line, Block Diagram Representation of Two Area System, Mechanical Analog of Two Area System, Dynamic Response of Two Area System, Static System Response, Tie-Line Bias Control of Multi-area Systems.	
UNIT – V	**8 Hrs.**
Power System Stability: The Stability Problem, Rotor Dynamics and the Swing Equation, Further Considerations of the Swing Equations, The Power-Angle Equation, Synchronizing Power Coefficients, Equal- Area Criterion for Stability, Further Applications of the Equal-Area Criterion, Multi-machine Stability Studies: Classical Representation, Step-By-Step Solution of the Swing Curve, Computer Programs for Transient Stability Studies, Factors Affecting Transient Stability	
Mode of Teaching: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert	
Text Books: 1. Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, Fifteenth Reprint. 2. An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH, Second Edition. 3. Power System Analysis, T K Nagsarkar and M S Sukhija, Oxford University Press	
Reference Books: 1. Power System Analysis- By HadiSaadat, TMH, 2002 Edition, Eighth Reprint. 2. Power System Analysis Operation and Control- By A. Chakrabarti and S. Haldar, Third Edition, PHI Publications, 6th Reprint, 2010.	

Subject Code	Name of the Subject	L	T	P	C
	PLC and SCADA	3	0	0	3

	Course Educational Objectives	
CEO1	Provide a comprehensive understanding of PLCs and their role in industrial automation.	
CEO2	Equip students with the skills to interface and program PLCs for various automation tasks.	
CEO3	Introduce SCADA systems and their integration with PLCs for industrial automation solutions.	
COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Explain the role, necessity, evolution, types, and comparisons of PLCs in automation.	2
CO2	Demonstrate interfacing PLCs with various I/O devices and control elements.	3
CO3	Develop PLC programs using ladder diagrams for specific automation tasks.	6
CO4	Describe SCADA architecture, features, and applications in critical infrastructure.	2
CO5	Analyze SCADA communication protocols and their industrial applications.	4
CO6	Integrate PLC and SCADA knowledge to design industrial automation solutions.	6

SYLLABUS

UNIT – I	**8 Hrs**
Introduction to PLC: Role of automation in Industries, benefits of automation, Necessity of PLC, History and evolution of PLC, Definition as per NEEMA (National Electrical Engineering Manufacturers' Association), types – fixed/modular/dedicated, Overall PLC system, PLC Input and output modules (along with Interfaces), CPU, programmers and monitors, power supplies, selection criterion, advantages and disadvantages, specifications, comparison of various PLCs manufactured by Allen Bradley, Siemens, ABB, Mitsubishi, GE, Fanuc and Schneider.	
UNIT – II	**8 Hrs**
Interfacing of PLC with I/O devices: Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices Sensors-temperature, pressure, flow, level Actuators-Electrical, pneumatic, hydraulic Encoders-Incremental, Absolute Transducers, Limit switches, proximity sensors Control Elements-Mechanical, Electrical, Fluid valves	
UNIT – III	**8 Hrs.**
Programming languages for PLC: Ladder diagram fundamentals, Rules for proper construction of ladder diagram Timer and counter-types along with timing diagrams, Reset instruction, latch instruction MCR (master control relay) and control zones Developing ladder logic for Sequencing of motors, ON OFF Tank level control, ON OFF temperature control, elevator, bottle filling plant, car parking, traffic light controller	
UNIT – IV	**10 Hrs.**
SCADA Systems:	

Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means, Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA. SCADA generations (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, Functions and features of SCADA systems, Automatic substation control, Energy management systems (EMS), System operating states, SCADA system in critical infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant.

UNIT – V	**6 Hrs.**

SCADA Protocols:

Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus).

Mode of Teaching:

Text Books:

1. John W. Webb, Ronald A. Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition
2. John R. Hackworth, Frederick D., Hackworth Jr., "Programmable Logic Controllers Programming Methods and Applications", PHI Publishers
3. Ronald L. Kurtz, "Securing SCADA System", Wiley Publishing
4. Stuart A Boyer, "SCADA supervisory control and data acquisition", ISA, 4th Revised edition
5. Sunil S. Rao, "Switchgear and Protection", Khanna Publication
6. Curtis Johnson, "Process Control Instrumentation Technology", Prentice Hall of India
7. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd Edition

Reference Books:

1. Gordan Clark, Deem Reynders, "Practical Modern SCADA Protocols", ELSEVIER
2. Batten G. L., "Programmable Controllers", McGraw Hill Inc., Second Edition
3. Bennett Stuart, "Real Time Computer Control", Prentice Hall, 1988
4. Krishna Kant, "Computer Based Industrial Control", PHI
5. P. K. Srivstava, "Programmable Logic Controllers with Applications", BPB Publications

Subject Code	Name of the Subject	L	T	P	C
	HYBRID ELECTRIC VEHICLES	3	0	0	3

	Course Educational Objectives
CEO1	Understand the fundamentals of conventional and electric vehicles, including their key components and evolution.
CEO2	Analyze and compare different HEVs, PHEVs, and advanced propulsion systems architectures.
CEO3	Apply power electronics principles and understand specialized electric machines and energy storage in EVs and HEVs.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Describe the fundamentals of conventional and electric vehicles, including their components.	2
CO2	Compare the different architectures of Hybrid Electric Vehicles (HEVs) and Plug-in Hybrid Electric Vehicles (PHEVs).	4
CO3	Evaluate the characteristics and control methods of special electric machines.	5
CO4	Apply power electronics principles in HEVs, focusing on converters, inverters, and battery charging systems.	3
CO5	Analyze various energy storage systems used in HEVs, including batteries, fuel cells, supercapacitors, and flywheels.	4
CO6	Demonstrate a comprehensive understanding of electric and hybrid electric vehicles, covering their design, operation, and integration.	2

SYLLABUS

UNIT – I	**8 Hrs**
Introduction Fundamentals of vehicle - components of conventional vehicle and propulsion load; Drive cycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; History of hybrid vehicles - advantages and applications of Electric and Hybrid Electric Vehicles.	
UNIT – II	**8 Hrs**
Hybridization of Automobile Architectures of HEVs - series and parallel HEVs - complex HEVs. Plug-in hybrid vehicle(PHEV) - constituents of PHEV - comparison of HEV and PHEV; Extended range hybrid electric vehicles(EREVs) - blended PHEVs - Fuel Cell vehicles and its constituents.	
UNIT – III	**8 Hrs**
Special Machines for EV and HEVs Characteristics of traction drive - requirement of electric motors for EV/HEVs. Induction Motor drives - their control and applications in EV/HEVs. Permanent magnet Synchronous motor: configuration - control and applications in EV/HEVs. Brushless DC Motors: Advantages - control of application in EV/HEVs. Switch reluctance motors: Merits limitations - converter configuration - control of SRM for EV/HEVs.	
UNIT – IV	**8 Hrs.**
Power Electronics in HEVs Boost and Buck-Boost converters - Multi Quadrant DC-DC converters - DC-AC Inverter for EV and HEV applications - Three Phase DC-AC inverters - Voltage control of DC-AC inverters using PWM - EV and PHEV battery chargers.	
UNIT – V	**8 Hrs**

Energy Sources for HEVs

Energy Storage - Battery based energy storage and simplified models of battery - fuel cells - their characteristics and simplified models - super capacitor based energy storage - its analysis and simplified models - flywheels and their modeling for energy storage in EV/HEV - Hybridization of various energy storage devices.

Mode of Teaching:

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. Ali Emadi - Advanced Electric Drive Vehicles - CRC Press - 2014.

Reference Books:

1. MehrdadEhsani - YimiGao - Sebastian E. Gay - Ali Emadi - Modern Electric - Hybrid Electric and Fuel Cell Vehicles: Fundamentals - Theoryand Design - CRC Press - 2004.
2. James Larminie - John Lowry - Electric Vehicle Technology Explained - Wiley - 2003.
3. H. Partab: Modern Electric Traction - DhanpatRai& Co - 2007.

Subject Code	Name of the Subject	L	T	P	C
	Electrical Standards & Electricity regulations	3	0	0	3

	Course Educational Objectives
CEO1	Provide a foundational understanding of power system planning, regulatory frameworks, and forecasting techniques.
CEO2	Equip students with the ability to analyze and apply power system standards and renewable energy integration practices.
CEO3	Develop critical assessment skills for electricity markets, tariff regulations, and emerging trends in electrical engineering.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Comprehend the essentials of power system planning, including national and regional frameworks, regulatory bodies, and forecasting techniques.	2
CO2	Analyze power system standards and grid codes, focusing on power quality, grid stability, and transmission/distribution standards.	4
CO3	Evaluate renewable energy integration standards and regulatory frameworks, with a focus on global case studies and best practices.	5
CO4	Examine electricity market structures and tariff regulations, emphasizing the role of regulation in promoting fair competition and open access.	4
CO5	Understand compliance and auditing procedures while identifying emerging trends in electrical standards and their implications.	2
CO6	Integrate knowledge of power planning, standards, and regulations to assess the impact of technological advancements and global trends on the future of electrical engineering.	6

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction of power planning, National and Regional Planning, structure of P.S. planning tools, Electricity Regulation, Electrical Forecasting, forecasting techniques modeling. Introduction to Electrical Standards and Regulations **Overview of Electrical Standards:** The importance and need for standards in electrical engineering, as well as the introduction to national and international standards organizations (e.g., IEEE, IEC, BIS), Electrical Safety Standards, Standards for electrical safety in installations (e.g., IS 732, IEC 60364), Overview of safety codes and regulations. **Electricity Regulations:** Introduction to electricity regulatory bodies (e.g., CEA, CERC, SERCs). Role of regulations in the electricity sector, Historical development of electricity regulations.	
UNIT – II	**8 Hrs.**
Power System Standards and Grid Codes: Grid Code Standards, Overview of Grid Codes and Their Importance, Detailed Study of Indian Electricity Grid Code (IEGC), Power Quality Standards, Standards for power quality (e.g., IEEE 519, IEC 61000), Voltage stability, frequency control, and harmonics standards, Transmission and Distribution Standards, Standards for overhead lines and cables (e.g., IS 5613, IS 1255), Transmission system planning and performance standards.	
UNIT – III	**14 Hrs.**
Renewable Energy Standards and Integration:	

Renewable Energy Standards: Standards for integrating renewable energy sources (e.g., IEC 61727, IEEE 1547), Grid integration of solar, wind, and other renewable energy sources.
Regulatory Framework for Renewables:
Policies and regulations for renewable energy (e.g., Renewable Purchase Obligation, Feed-in Tariffs), Net metering regulations and standards, Case Studies: Case studies of renewable energy integration in different countries.

UNIT – IV	**8 Hrs.**

Electricity Market Regulations and Tariffs:
Electricity Market Structures, Overview of different electricity market models, Role of regulations in electricity markets.
Tariff Regulations: Tariff determination process and regulatory principles, Time-of-use tariffs, demand charges, and other pricing mechanisms, Open Access and Regulatory Policies, Policies related to open access in transmission and distribution, and Role of regulators in ensuring fair competition.

UNIT – V	**8 Hrs.**

Compliance, Auditing, and Future Trends in Electrical Standards
Compliance and Auditing, Procedures for compliance with electrical standards, Auditing of electrical installations and systems, Emerging Trends, and Future trends in electrical standards and regulations.
Impact of smart grids, IoT, and digitalization on electrical standards.
Global Harmonization of Standards, efforts towards the global harmonization of electrical standards, Challenges and opportunities in the standardization process.

Mode of Teaching:

Text Books:

1. Electrical Power Systems: Concepts, Theory, and Practice" by Hadi Saadat, Publisher: McGraw Hill Education, 4th edition, 2015
2. Indian Electricity Laws and Regulations" by Dr. S. K. Bhatia, Publisher: Universal Law Publishing. 3rd edition, 2012
3. Power System Engineering" by D. P. Kothari and I. J. Nagrath, 2nd Edition, 2008, McGraw Hill Education

Reference Books:

1. Guide to Indian Power Sector" by N. K. Jain, Publisher: Notion Press
2. Electricity Act 2003 with Indian Electricity Rules 1956" by P. M. Bakshi, Publisher: Universal Law Publishing
3. Handbook of Electrical Installation Practice" by Geoffrey Stokes, Publisher: Wiley-Blackwell

Subject Code	Name of the Subject	L	T	P	C
	SPECIAL ELECTRICAL MACHINES	3	0	0	3

	Course Educational Objectives
CEO1	Provide a thorough understanding of permanent magnet materials and their applications in PMDC motors
CEO2	Equip students to analyze and design special electrical motors, including stepper motors, SRMs, and PMBLDC motors
CEO3	Enable students to understand the principles and applications of Linear Induction Motors, particularly in traction systems

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Classify the properties and applications of permanent magnet materials in electrical machines, focusing on PMDC motors.	4
CO2	Explain the operation, construction, and control techniques of stepper motors, both open-loop and closed-loop systems.	2
CO3	Compare the design, operation, and applications of Switched Reluctance Motors with conventional motors.	4
CO4	Evaluate the construction, performance, and applications of Permanent Magnet Brushless DC Motors, including torque-speed characteristics.	5
CO5	Understand the principles, construction, and applications of Linear Induction Motors, with a focus on their use in traction systems.	2
CO6	Demonstrate a comprehensive understanding of special electrical motors, including PMDC, stepper, SRM, BLDC, and LIMs, with respect to their principles and industrial applications.	2

SYLLABUS

UNIT – I	**8 Hrs.**
Permanent Magnet Materials and PMDC motors Introduction - classification of permanent magnet materials used in electrical machines - minor hysteresis, loop and recoil line - Stator frames of conventional dc machines - Development of electronically commutated DC motor from conventional DC motor – Permanent magnet materials and characteristics – BH loop and demagnetization characteristics temperature effects-reversible losses - Irreversible losses - Mechanical properties - handling and magnetization - Application of permanent magnets in motors - power density - operating temperature range - severity of operation duty- Hysteresis - Eddy current Motors.	
UNIT – II	**8 Hrs.**
Stepper Motors Principle of operation of Stepper Motor – Constructional details - Classification of stepper motors – Different configuration for switching the phase windings - Control circuits for stepper motors – Open loop and closed loop control of two-phase hybrid stepping motor.	
UNIT – III	**8 Hrs.**
Switched Reluctance Motors Construction and Principle of operation of Switched Reluctance Motor – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs. Torque producing principle and torque expression – Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM.	
UNIT – IV	**8 Hrs.**

Permanent Magnet Brushless DC Motor

Principle of operation of BLDC motor - Types of constructions - Surface mounted and interior type permanent magnet DC Motors - Torque and EMF equations for Square wave & Sine wave for PMBLDC Motor – Torque - Speed characteristics of Square wave & Sine wave for PMBLDC Motor - Merits & demerits of Square wave & Sine wave for PMBLDC Motor - Performance and efficiency – Applications.

UNIT – V	**8 Hrs.**

Linear Induction Motors (LIM)

Construction– principle of operation – Double sided LIM from rotating type Induction Motor – Schematic of LIM drive for traction – Development of one-sided LIM with back iron - equivalent circuit of LIM.

Mode of Teaching:

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford.
2. Special electrical Machines, K.Venkata Ratnam, University press, 2009, New Delhi.

Reference Books:

1. "Special Electrical Machines" by E.G. Janardanan, PHI Learning Pvt. Ltd., 1st Edition, 2014.
2. "Brushless Permanent-Magnet and Reluctance Motor Drives" by Timothy J.E. Miller, Clarendon Press, Oxford University Press, 1st Edition, 1989.
3. "Permanent Magnet Synchronous and Brushless DC Motor Drives" by R. Krishnan, CRC Press, 1st Edition, 2009.
4. "Stepper Motors: Fundamentals, Applications, and Design" by V.V. Athani, New Age International Publishers, 2nd Edition, 2011.
5. "Electric Motor Drives: Modeling, Analysis, and Control" by R. Krishnan, Pearson Education, 1st Edition, 2001.
6. "Analysis of Electric Machinery and Drive Systems" by Paul C. Krause, Oleg Wasynczuk, and Scott D. Sudhoff, Wiley-IEEE Press, 2nd Edition, 2002.

Subject Code	Name of the Subject	L	T	P	C
	HVDC Transmission	3	0	0	3

	Course Educational Objectives	
CEO1	Provide an understanding of HVDC power transmission technology, focusing on converter analysis and modern trends.	
CEO2	Equip students with skills in HVDC system control, protection, and harmonic mitigation.	
CEO3	Develop proficiency in the control and protection of Multi-Terminal DC systems and related components.	
COs	**Course Educational Objectives**	**BTL**
CO1	Analyze the evolution, types, and converter configurations of DC power transmission, with a focus on 6-pulse and 12-pulse converters.	4
CO2	Apply control principles in HVDC systems, including various converter control methods and power management techniques.	3
CO3	Evaluate protection strategies for HVDC systems, addressing converter faults, overvoltage protection, and the role of surge arrestors and smoothing reactors.	5
CO4	Understand reactive power control methods in HVDC systems, including the use of SVC, STATCOM, and harmonic mitigation through filters.	2
CO5	Examine the structure, control, and protection of Multi-Terminal DC systems, including DC insulation and circuit breaker characteristics.	4
CO6	Develop a comprehensive understanding of HVDC technology, encompassing control, protection, reactive power management, and MTDC systems.	6

SYLLABUS

UNIT – I	**8 Hrs.**
DC Power Transmission Technology Introduction - Historical Development - Comparison of AC and DC transmission - types of DC links - Existing HVDC Projects in INDIA. Modern Trends in HVDC Technology. Analysis of HVDC Converters, Three Phase 6-Pulse bridge converter - simplified analysis - waveform with and without overlap - Current and voltage relationship - Equivalent circuits of converters - Analysis of a 12 pulse converters.	
UNIT – II	**8 Hrs.**
HVDC System Control Principles of DC link control - converter control characteristics - constant current and constant extinction angle control - constant ignition angle control - starting and stopping of HVDC link – power control & power reversal in HVDC link.	
UNIT – III	**8 Hrs.**
Converter Faults and Protection Over voltages in converter station - Surge arrestors - Protection against over voltages and over currents. Converter faults - Protection against faults in voltage source converter-Smoothing Reactor – Transient over voltages for DC line – Protection of DC lines.	
UNIT – IV	**8 Hrs.**
Reactive Power Control Sources of reactive power - Static VAR system – SVC and STATCOM - Reactive power control during transients. Harmonics & Filters, Generation of harmonics – Types and design of various AC filters - DC filters – Active Filters.	
UNIT – V	**8 Hrs.**
Multi-Terminal HVDC Systems & DC Circuit Breakers Types of MTDC systems - Control and Protection of MTDC system – HVDC insulation – DC line insulators – DC breakers – Characteristics and types of DC breakers.	
Mode of Teaching:	

Text Books:

1. K. R. Padiyar - "HVDC Power Transmission Systems Technology and System Interactions" - New Age International (p) Limited - New Delhi - 2003.
2. Edward Wilson Kimbark - "Direct current Transmission" - Wiley Interscience - Vol. I - NewYork - 1971.

Reference Books:

1. Vijay K. Sood - "HVDC and FACTS Controller: Application of Static Converters in power
2. systems" - IEEE Power Electronics and Power Systems series - Kluwer Academic publishers - Boston - First edition January 2004.
3. C. Adamson and N.G. Hingorani - "High voltage DC power Transmission" – Garraway Limited - England - 1960.
4. Mohan - Undeland and Robbins - "Power Electronics Converters - Applications and Design – John Wiley & Son - Inc. - 2003.
5. J. Arrialga - "HVDC Transmission" - Peter Peregrinus Ltd. - London - 1983.

Subject Code	Name of the Subject	L	T	P	C
	INTERNET OF THINGS	3	0	0	3

	Prerequisites
1	Basic Programming Knowledge: Familiarity with programming languages such as Python, C, or C++ is essential, as the course involves programming microcontrollers and working with APIs.
2	Understanding of Computer Networks: Basic networking concepts, including TCP/IP, communication protocols, and data transmission, will help students grasp IoT networking and communication protocols like MQTT, ZigBee, and Bluetooth.
3	Fundamentals of Electronics: A basic understanding of electronics, including circuits, sensors, and microcontrollers, is essential for working with hardware components like Arduino and Raspberry Pi.
4	Basic Cloud Computing Concepts: Some familiarity with cloud computing concepts will be beneficial, as the course covers the role of cloud services in IoT.

	Course Educational Objectives
CEO1	Provide a comprehensive understanding of IoT principles, architecture, applications, and security.
CEO2	Enable hands-on experience in developing IoT solutions using hardware, programming APIs, and communication protocols.
CEO3	Apply IoT knowledge to design and implement applications in various sectors, focusing on data management and security.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand the architectural principles, IoT applications, and essential capabilities required for IoT implementation.	2
CO2	Analyze the hardware and software components, including computing devices, communication protocols, and programming APIs.	4
CO3	Develop IoT solutions using Python, Arduino, and Raspberry Pi, with an understanding of cloud computing.	3
CO4	Design IoT applications by integrating devices, acquiring and managing data, and ensuring secure storage and authorization within an IoT framework.	6
CO5	Apply IoT concepts through case studies in various sectors, demonstrating practical implementations.	3
CO6	Demonstrate comprehensive knowledge and practical skills in IoT, from foundational concepts to application development.	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to IoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT. **Domain-Specific IOTs:** Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style.	
UNIT – II	**8 Hrs.**
Elements of IoT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	

UNIT – III	8 Hrs.

Developing IoT solutions:

Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi Implementation of IoT with Arduino and Raspberry, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

UNIT – IV	8 Hrs.

IoT Application Development:

Solution framework for IoT applications, Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

UNIT – V	8 Hrs.

IoT Case Studies:

IoT case studies based on Industrial Automation, Transportation, Agriculture, Healthcare, Home Automation and Energy related applications.

Mode of Teaching:

Text Books:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2. VijayMadisetti, ArshdeepBahga," Internet of ThingsA Hands- On-Approach",2014,ISBN:978 0996025515
3. Dr. SRN Reddy, RachitThukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
4. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
5. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi

Reference Books:

1. AdrianMcEwen, "Designing the Internet of Things", Wiley Publishers, 2013, ISBN:978-1-118-43062-0
2. Daniel Kellmereit, "The Silent Intelligence: The Internet of Things". 2013, ISBN:0989973700
3. Adrian McEwen, "Designing the Internet of Things", Wiley
4. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
5. CunoPfister, "Getting Started with the Internet of Things", O Reilly Media

Subject Code	Name of the Subject	L	T	P	C
	MEAN STACK TECHNOLOGIES	3	0	0	3

	Course Educational Objectives
CEO1	Equip students with skills to design and structure web pages using HTML, DHTML, and CSS.
CEO2	Provide hands-on experience in developing dynamic web applications using client-side and server-side scripting languages.
CEO3	Ensure practical knowledge in web development, focusing on database connectivity, web server setup, and modern web frameworks.

COs	**Course Educational Objectives**	**BTL**
CO1	Design web pages using HTML and DHTML, incorporating CSS and XML for structured and visually appealing content	6
CO2	Implement interactive client-side functionality using JavaScript, integrating AJAX for dynamic and responsive web applications	3
CO3	Develop server-side web applications utilizing Java Servlets, JSP, and JSF, focusing on session management and secure data handling	6
CO4	Create dynamic web applications in PHP, effectively processing forms, handling files, and managing cookies.	6
CO5	Connect web applications to databases using JDBC, with a focus on MySQL, MongoDB, and NoSQL, while enhancing the user interface with jQuery and Bootstrap	3
CO6	Apply comprehensive web development techniques, combining client-side and server-side technologies, database connectivity, and modern web frameworks	3

SYLLABUS

UNIT – I	**8 Hrs.**
HTML & DHTML Introduction, HTML Formatting, Hyper-Links, Lists, Tables, Images, Forms, Frames, Cascading Style sheets, Types, XML, Document type definition, XML Schemas, Document Object model, HTML and Scripting Access, Rollover Buttons, Moving objects with DHTML, Ramifications of DHTML.	
UNIT – II	**8 Hrs.**
Introduction to Client Side scripting JavaScript, Control statements, Functions, Arrays, Objects, Events, Dynamic HTML with Java Script, AJAX: Ajax Client Server Architecture, XML Http Request Object, Call Back Methods.	
UNIT – III	**8 Hrs.**
Web Application Web servers, IIS (XAMPP, LAMPP) and Tomcat Servers, Server Side Scripting, Java Servlets, Java Server Pages, Java Server Faces, JSF Components, Session Tracking, Cookies**.**	
UNIT – IV	**8 Hrs.**
PHP Programming: Basic Syntax, Defining variable and constant, PHP Data types, Operator and Expression, Operator Precedence, Decisions and Loop, Functions & Recursion, String Processing and Regular Expressions, Form Processing, Working with file and Directories, Cookies.	
UNIT – V	**8 Hrs.**
JDBC Database Connectivity with MySQL, Servlets, JSP, PHP, MongoDB, NOSQL Database, Fundamentals of JQuery and Bootstrap. Case Studies - Student information system, Health Management System	

Mode of Teaching:

Text Books:

1. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel, "Internet & World Wide Web How to Program", Fifth Edition, Deitel Series, 2012.
2. Jason Gilmore, "Beginning PHP and MySQL from Novice to Professional", Fourth Edition, A press Publications, 2010.

Reference Books:

1. Brown, Ethan, "Web Development with Node and Express: Leveraging the JavaScript Stack", O'Reilly Media, 2019. CSE Dept. Flexible Curriculum NITTUGCSE19 95.
2. Anthony, Accomazzo, Murray Nathaniel, Lerner Ari, "Fullstack React: The Complete Guide to React JS and Friends", Fullstack.io, 2017.
3. Kozlowski, Pawel, "Mastering Web Application Development with Angular JS", Packt Publishing Ltd., 2013.
4. Robert W. Sebesta, "Programming with World Wide Web", Fourth Edition, Pearson, 2008.

Subject Code	Name of the Subject	L	T	P	C
	Computer Architecture and Organization	3	0	0	3

	Course Educational Objectives
CEO1	Understand the fundamental concepts and architecture of computer systems, including instruction cycles and memory-reference instructions
CEO2	Analyze and design key components of computer systems, focusing on the CPU, memory organization, and input/output subsystems
CEO3	Apply principles of register transfer, micro-operations, and control to design and implement computer systems

COs	**Upon successful completion of this course, students should be able to:**	BTL
CO1	Describe the fundamental concepts of basic computer organization, including instruction cycles and memory-reference instructions.	2
CO2	Explain the principles of register transfer, micro-operations, and microprogrammed control.	2
CO3	Analyze the structure and functionality of the Central Processing Unit (CPU), including general register organization.	4
CO4	Understand the organization and operation of input/output systems, including peripheral devices, DMA, and I/O processors, and their role in serial communication.	2
CO5	Illustrate the memory organization concepts, covering memory hierarchy, cache, virtual memory, and memory management hardware.	3
CO6	Comprehend the overall architecture of computer systems, integrating knowledge of CPU design, memory systems, and I/O subsystems.	2

SYLLABUS

UNIT – I	**8 Hrs.**
Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, Input- Output and Interrupt, Complete Computer Description, Design of Basic Computer, Design of Accumulator Logic.	
UNIT – II	**8 Hrs.**
Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit. Micro programmed Control: Control Memory, Address Sequencing, Micro program Example, Design of Control Unit.	
UNIT – III	**8 Hrs.**
Central Processing Unit: Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer(RISC) Pipeline and Vector Processing: Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISK Pipeline, Vector Processing, Array Processors.	
UNIT – IV	**8 Hrs.**
Input/output Organization: Peripheral Devices, I/O interface, Asynchronous data transfer, Modes of transfer, priority Interrupt, Direct memory access, Input-Output Processor (IOP), Serial Communication.	
UNIT – V	**8 Hrs.**
Memory Organization:	
Memory Hierarchy, Main memory, Auxiliary memory, Associate Memory, Cache Memory, and Virtual memory, Memory Management Hardware.	
Mode of Teaching:	

Text Books:

1. Computer System Architecture, M. Morris Mano, Prentice Hall of India Pvt. Ltd., 3rd Edition, Sept. 2008.

Reference Books:

1. Computer Architecture and Organization, William Stallings, PHI Pvt. Ltd., Eastern Economy Edition, Sixth Edition, 2003.
2. Computer Organization and Architecture, Linda Null, Julia Lobur, Narosa Publications ISBN 81- 7319-609-5
3. Computer System Organization by John. P. Hayes.

Subject Code	Name of the Subject	L	T	P	C
	LINEAR IC APPLICATIONS	3	0	0	3

	Course Educational Objectives
CEO1	Understand and apply operational amplifiers in analog circuits, including voltage regulators and power supplies
CEO2	Design and analyze active filters, waveform generators, and timing circuits using Op-Amps, 555 timers, and PLLs
CEO3	Explore and integrate digital-to-analog and analog-to-digital conversion techniques in electronic systems.

COs	**Course Educational Objectives**	**BTL**
CO1	Understand the fundamental characteristics, specifications, and parameters of operational amplifiers and their design.	2
CO2	Apply operational amplifiers in various configurations, including instrumentation amplifiers, converters, and waveform generators.	3
CO3	Design active filters, including low-pass, high-pass, band-pass, band-reject, and all-pass filters using the Butterworth method	6
CO4	Analyze the operation and applications of 555 timers and Phase Locked Loops (PLLs) in various electronic circuits.	4
CO5	Explore digital-to-analog (DAC) and Analog-to-Digital Converters (ADC), including different DAC techniques and ADC types.	2
CO6	Integrate analog and digital circuit design knowledge, including Op-Amps, filters, timers, PLLs, DACs, and ADCs.	5

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction: OP-Amp Block Diagram (Symbolic Representation), Characteristics of Op-Amp, Ideal and Practical Op-Amp specifications, DC and AC Characteristics, Definitions of Input and Output Off-set voltage and currents slow rate, CMRR, PSRR. Measurements of Op-Amp Parameters, Three-Terminal Voltage Regulators 78xx& 79xx Series, current Booster, adjustable voltage, DualPowerSupplywith78xx&79xx	
UNIT – II	**8 Hrs.**
OP-AMPS Applications: Introduction, Basic Op-Amp Applications, Instrumentation Amplifier, AC Amplifier, V to I and I to V Converter, Sample and Hold Circuit, Log and Antilog Amplifier, Multiplier and Divider, Differentiator, integrator. Comparators and Waveform Generators: Introduction, Comparator, Square Wave Generator, Monostable Multivibrator, Triangular Wave Generator, Sine Wave Generators.	
UNIT – III	**8 Hrs.**
Active Filters: Design & Analysis of Butterworth active filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and all pass filters.	
UNIT – IV	**8 Hrs.**
Timers: Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger.	
Phase Locked Loops: Introduction, block schematic, principles and description of individual blocks, 565 PLL, Applications of PLL – frequency multiplication, frequency translation, AM, FM & FSK demodulators. Applications of VCO (566)	

UNIT – V	8 Hrs.
Digital To Analog And Analog To Digital Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A-D Converters – parallel Comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC.DAC and ADC Specifications.	
Mode of Teaching:	
Text Books: 3. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition 2003. 4. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma; SK Kataria & Sons; 2nd Edition, 2010	
Reference Books: 4. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI, 1993. 5. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition.	

R2023
[2023-27]

VII Semester [Fourth Year]
B. Tech in Electrical Engineering

S.N.	Category	Course Code	Course title	Hours/week			C	CIA	SEE
				L	T	P			
1	PC	23BELPC47001	Electric Drives	3	0	0	3		
2	PE	23BELPE4701*	Professional Elective – III	3	0	0	3		
3	PE	23BELPE4702*	Professional Elective – IV	3	0	0	3		
4	OE	23BELOE4701*	Open Elective – III	3	0	0	3		
5	HS	23BHSHS47001	Entrepreneurship Development	3	0	0	3		
PRACTICAL / SESSIONAL									
6	PC	23BELPC47102	Simulation Lab	0	0	2	1		
7	PST	23BELPW47101	Technical Seminar	0	0	2	1		
8	PST	23BELPW47102	Minor Project	0	0	4	2		
9	PST	23BELPW47103	Summer Internship – III	-	-	-	1		
			TOTAL	15	0	8	20		
			Cumulative Total	111	4	88	149		

Machine Learning with Python

Professional Elective – III		
	Course Code	Course title
1	23BELPE47011	Power Station Engineering & Economy
2	23BELPE47012	High Voltage Engineering
3	23BELPE47013	Digital Signal Processing
4	23BELPE47014	Power Quality

Professional Elective – IV		
	Course Code	Course title
1	23BELPE47021	Smart Grid Technologies
2	23BELPE47022	Battery Management Systems and Charging Stations
3	23BELPE47023	Advanced Control Systems
4	23BELPE47024	AI Applications to Electrical Engineering

Open Elective – III		
	Course Code	Course title
1	23BELOE47011	Introduction to Machine Learning
2	23BELOE47012	Cloud Computing with AWS
3	23BELOE47013	Basics of Quantum Computing
4		Blockchain technologies

Subject Code	Name of the Subject	L	T	P	C
	ELECTRIC DRIVES	3	0	0	3

	Course Educational Objectives	
CEO1	To provide students with a strong background in different types of electrical drives.	
CEO2	To train the students to have a solid foundation in mathematical and technical concepts required for engineering problems.	
CEO3	It prepares the students to excel in postgraduate programs or succeed in the industry.	
CEO4	To provide a foundation in the theory and applications of electrical machinery and their different types concerning their control.	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Understand the stable steady state operation and transient dynamics of the motor-load system	2
CO2	Analyse characteristics and different control strategies of solid-state DC motor drives.	4
CO3	Classify the role of power electronic converters in the control of DC motor drives.	3
CO4	Distinguish the characteristics and control of various Induction motor drives.	3
CO5	Determine the applications of various synchronous motor drives used in Industries.	3
CO6	Develop the digital control methodology of AC and DC drives.	5

SYLLABUS

UNIT – I	**8 Hrs.**
REVIEW OF ELECTRIC DRIVES Fundamentals of Electric Drives-Advantage of Electric Drives-selection of Motor power rating-Thermal model of motor for heating and cooling - Classes of duty cycle-Determination of motor rating -control of Electric drives- modes of operation - speed control and drive classifications - closed-loop control of drives.	
UNIT – II	**8 Hrs.**
CONTROL OF DC DRIVES DC Motor Drives: DC motor and their performance-Braking - Transient analysis - Ward Leonard drives - Transformer and uncontrolled rectifier control – controlled rectifier fed DC drives - Chopper controlled DC drives - Time ratio control and current limit control - Single, two and four quadrant operations - Effect of ripples on the DC motor performance.	
UNIT – III	**8 Hrs.**
CONTROL OF AC DRIVES Induction Motor Drives-Stator control-Stator voltage and frequency control-VSI,CSI and cyclo converter fed induction motor drives –open loop and closed VVVF control - Rotor resistance control and slip power recovery schematic control of rotor resistance using DC chopper-Vector Control basic concepts.	
UNIT – IV	**8 Hrs.**
Synchronous Motor Drives: Speed control of three phase synchronous motors Voltage and current source fed synchronous motor-Cyclo converter fed synchronous motors-Effects of harmonics on the performance of AC motors	
UNIT – V	**8 Hrs.**
DIGITAL TECHNIQUE IN SPEED CONTROL Digital Control and Drive Applications-Digital technique in speed control of electric drive system-Advantages and limitations - microcontroller based control of drives- selection of drives and control schemes for electrical vehicle Application, paper mills, lifts and cranes.	

Text Books:

1. Dubey.G.K. "Fundamentals of Electrical drives", Narora publications, 1995.
2. Bose. B.K. "Power Electronics and Variable frequency drives", 1st edition, IEEE Press Standard Publications 2002.

Reference Books:

1. Mazidi and Mazidi, "Intel 8051 Microcontrollers", Pearson education, India, 2006.
2. R. Krishnan, "Electric motor drives Modeling, Analysis and Control", 1st edition, Pearson Publications, 2009.
3. Gaekward, "Analog and Digital control systems", Wiley Eastern Ltd, 1989.
4. VedamSubramanyan, "Thyristor control of Electrical Drives", Tata McGraw Hill, Publications, 1996

Subject Code	Name of the Subject	L	T	P	C
	Power Station Engineering and Economy	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape.
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction: Introduction to different sources of energy and general discussion on their application to generation, Indian Energy Scenario. Load duration curves, Load Factor, Capacity Factor, Reserve Factor, Demand Factor, Diversity Factor, Plant Use Factor, Base Load, Intermediate Load and Peak Load Plants. **ECONOMICS OF POWER GENERATION:** Construction costs, Fixed cost and Depreciation, Fuel cost, Economic scheduling principle, Annual Operating Costs, Effect of Load Factor on cost per kWh.	
UNIT – II	**8 Hrs.**
NUCLEAR POWER STATION: Introduction to fission & fusion, reactor construction, controlled chain reaction, operational control of reactors, Brief study of various types of reactors (Boiling water, pressurized water, heavy water, breeder) , Location and layout of nuclear power plant **GAS POWER STATIONS:** Basics of gas power stations, including their components and fuel types. gas turbine operation, performance parameters, and combined cycle plants. Environmental and economic considerations, emissions control.	
UNIT – III	**8 Hrs.**
HYDEL POWER STATION: Selection of site for hydro-electric power plant. Hydrology: Hydrological cycle, precipitation, run-off and its measurement, hydrograph, flow duration and mass curves, Estimation of amount stored	

by a dam across the river, Storage and Pondage. Turbines: Operational principle of Kaplan and Francis Turbine and Pelton wheel, Speed and Pressure Regulation, Work done, efficiency Essential Elements of a Hydro-electric Power Plant: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes and Tail Race, Power House, Classification of Hydroelectric Power Plants., Governors, Plant auxiliaries

UNIT – IV	**8 Hrs.**

THERMAL POWER STATION:

Selection of site for thermal power plant. Overall Block Diagram indicating the air circuit, coal and ash circuit, water and steam circuit, various types of steam turbines, ash and coal handling system, High Pressure and High capacity water tube boilers, Economizer, Superheaters, De-Superheater, Reheater, Air Pre-heater. Draft System: Natural, Induced Forced and Balance Draft, PA fan, FD fan, ID fan, Chimney. Condensers, Feed water heaters, Evaporators, Make-up water, Bleeding of steam, Cooling water system. (Vopat- Electrostatic Precipitator: Basic working Principle and constructional details Governors, Plant auxiliaries

UNIT – V	**8 Hrs.**

Unit Cost of Solar Power and Wind Power Calculations:

Overview of cost components for solar and wind power, including capital costs, operational costs, and maintenance.Detailed methods for calculating the Levelized Cost of Energy (LCOE) for solar and wind power., Factors Affecting Costs: Impact of location, scale, technology, and financing on the unit cost of solar and wind power, Comparison of Solar and Wind Power Costs, Analyzing and comparing the unit costs of solar and wind energy under different scenarios.

Case Studies and Practical Applications: Real-world examples of cost calculations and decision-making for solar and wind power projects.

Mode of Teaching:

Text Books:

1. P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication
2. Bernhardt G. A. Skrotzki, William A. Vopat, 'Power Station Engineering and Economy', 2nd Edition, Tata McGraw Hill Publication
3. Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle (Oxford University Press, 4th Edition, 2017)

Reference Books:

1. M. V. Deshpande, Elements of Electrical Power Station Design, PHI
2. Arora &Domkundwar, 'A Course in Power Plant Engineering', DhanpatRai and sons.
3. R. K. Rajput, 'AText Book of Power Plant Engineering', 3rd Edition, Laxmi Publishing
4. Wind and Solar Power Systems: Design, Analysis, and Operation" by Mukund R. Patel (CRC Press, 2nd Edition, 2005)

Subject Code	Name of the Subject	L	T	P	C
	High Voltage Engineering	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**14Hrs**
Break down phenomenon in Gaseous: Insulating Materials: Types - applications and properties. Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases and its limitations – Streamers Theory of break down – Paschen's law- Paschens curve.	
UNIT – II	**8 Hrs.**
Break down phenomenon in Liquids: Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquids. Break down phenomenon in Solids: Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of composite solid dielectrics.	
UNIT – III	**8 Hrs..**
Generation of High DC voltages: Voltage Doubler Circuit - Voltage Multiplier Circuit – Vande- Graaff Generator. Generation of High AC voltages: Cascaded Transformers – Resonant Transformers –Tesla Coil	
UNIT – IV	**8 Hrs.**
Generation of Impulse voltages: Specifications of impulse wave – Analysis of RLC circuit only- Marx Circuit. Generation of Impulse currents:	
Definitions – Circuits for producing Impulse current waves – Wave shape control - Tripping and control of impulse generators.	
UNIT – V	**8 Hrs.**

Measurement of High DC & AC Voltages:
Resistance potential divider - Generating Voltmeter - Capacitor Voltage Transformer (CVT) - Electrostatic Voltmeters – Sphere Gaps.

Text Books:

1. High Voltage Engineering: Fundamentals by E.Kuffel - W.S.Zaengl - J.Kuffel by Elsevier - 2nd Edition.
2. High Voltage Engineering and Technology by Ryan - IET Publishers - 2nd edition.

Reference Books:

1. High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications - 3rd Edition.
2. High Voltage Engineering by C.L.Wadhwa - New Age Internationals (P) Limited – 1997.
3. High Voltage Insulation Engineering by RavindraArora - Wolfgang Mosch - New Age International (P) Limited - 1995.

Subject Code	Name of the Subject	L	T	P	C
	DIGITAL SIGNAL PROCESSING	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape.
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction Introduction to Digital Signal Processing: Discrete time signals & sequences - Classification of Discrete time systems - stability of LTI systems - Invertability - Response of LTI systems to arbitrary inputs. Solution of Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems. Review of Z-transforms - solution of difference equations using Z-transforms - System function.	
UNIT – II	**8 Hrs.**
Discrete Fourier Transforms and FFT Algorithms Discrete Fourier Series representation of periodic sequences -Properties of Discrete Fourier Series - Discrete Fourier transforms: Properties of DFT - linear filtering methods based on DFT - Fast Fourier transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms - Inverse FFT.	
UNIT – III	**8 Hrs.**
Design and Realizations of IIR Digital Filters Analog filter approximations – Butter worth and Chebyshev - Design of IIR Digital filters from analog filters - Design Examples. Analog and Digital frequency transformations.	
Basic structures of IIR systems – Direct-Form Structures - Transposed Structures - Cascade-Form Structures - Parallel-Form Structures Lattice and Lattice-Ladder Structures.	
UNIT – IV	**8 Hrs.**

Design and Realizations of FIR Digital Filters

Characteristics of FIR Filters with Linear Phase - Frequency Response of Linear Phase FIR Filters - Design of FIR Digital Filters using Window Techniques and Frequency Sampling technique - Comparison of IIR & FIR filters.

Basic structures of FIR systems – Direct-Form Structure - Cascade-Form Structures Linear Phase Realizations - Lattice structures.

UNIT – V	**8 Hrs.**

Multirate Digital Signal Processing

Introduction-Decimation –Interpolation-Sampling Rate Conversion by a Rational Factor-Implementation of sampling rate converters-Applications of Multirate Signal Processing-Digital Filter Banks.

Mode of Teaching:

Text Books:

1. Digital Signal Processing - Principles - Algorithms - and Applications: John G. Proakis - Dimitris G.Manolakis - 4th Edition - Pearson Education / PHI - 2007.
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer - PHI.
3. Digital Signal Processing: A Computer based approach. Sanjit K Mitra - 4th Edition - TMH - 2014.

Reference Books:

1. Digital Signal Processing: Andreas Antoniou - TATA McGraw Hill - 2006
2. Digital Signal Processing: MH Hayes - Schaum's Outlines - TATA Mc-Graw Hill - 2007.
3. DSP Primer - C. Britton Rorabaugh - Tata McGraw Hill - 2005.
4. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling - Sandra L.Harris - Thomson - 2007.
5. Digital Signal Processing – Alan V. Oppenheim - Ronald W. Schafer - PHI Ed. - 2006.
6. Digital Signal Processing – K Raja Rajeswari - 1st edition - I.K. International Publishing - House - 2014.

Subject Code	Name of the Subject	L	T	P	C
	POWER QUALITY	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**8 Hrs**
Introduction - Terms & Definitions Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.	
UNIT – II	**8 Hrs**
Transient Over Voltages Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.	
UNIT – III	**8 Hrs**
Long – Duration Voltage Variations Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker	
UNIT – IV	**8 Hrs.**
Harmonic distortion and solutions Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors, transformers, motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.	

UNIT – V	8 Hrs

Distributed Generation and Monitoring

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

Mode of Teaching:

Text Books:

1. Electrical Power Systems Quality - Dugan R C - McGranaghan M F - Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley india publications - 2011.
3. Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

1. Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ – First Edition - IEEE Press; 2000.
2. Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons -2003.
3. Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula - Van Nostrad Reinhold - New York.
4. Power Quality C.Shankaran - CRC Press - 2001
5. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis)
6. Power Quality in Power systems and Electrical Machines–EwaldF.fuchs – Mohammad A.S.Masoum–Elsevier.

Subject Code	Name of the Subject	L	T	P	C
	SMART GRID TECHNOLOGIES	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to Smart Grid Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid -Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid.	
UNIT – II	**8 Hrs.**
Smart Grid Technologies: Part 1 Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading(AMR) - Outage Management System(OMS) - Plug-in Hybrid Electric Vehicles(PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Phase Shifting Transformers – Net Metering, Virtual Net Metering.	
UNIT – III	**8 Hrs..**
Smart Grid Technologies: Part 2 Smart Substations - Substation Automation - Feeder Automation. Geographic Information System(GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection. Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting Magnetic Energy Storage Systems (SMES) - Pumped Hydro - Compressed Air Energy Storage (CAES)	
UNIT – IV	**8 Hrs.**
Micro grids and Distributed Energy Resources	
Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources – Demand Response.	

UNIT – V	8 Hrs.

Information and Communication Technology for Smart Grid

Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighbourhood Area Network (NAN) - Wide Area Network (WAN).

Mode of Teaching:

Text Books:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W.Gellings - Fairmont Press - 2009.
3. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins – Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.
4. Smart Grids by Jean-Claude Sabonnadière - NouredineHadjsaïd - Wiley publishers – 2013.
5. Smart Power: Climate Changes - the Smart Grid - and the Future of Electric Utilities - by Peter S. Fox Penner - Island Press; 1st edition - 8 Jun 2010
6. Microgrids and Active Distribution Networks by S. Chowdhury - S. P. Chowdhury - P.Crossley - Institution of Engineering and Technology - 30 Jun 2009

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Control and Automation of Electric Power Distribution Systems (Power Engineering) by James Northcote - Green - Robert G. Wilson - CRC Press - 2017.
3. Substation Automation (Power Electronics and Power Systems) by Mladen Kezunovic - Mark G. Adamiak - Alexander P. Apostolov - Jeffrey George Gilbert - Springer - 2010.
4. Electrical Power System Quality by R. C. Dugan - Mark F. McGranghan - Surya Santoso - H. Wayne Beaty - McGraw Hill Publication - 2nd Edition.

Subject Code	Name of the Subject	L	T	P	C
	BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction: Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical, and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging, Battery Capacity rating calculations.	
UNIT – II	**8 Hrs.**
Battery Management System: Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of- charge estimation, Cell total energy and cell total power.	
UNIT – III	**8 Hrs.**
Battery State of Charge & Balancing: Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model- based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing.	
UNIT – IV	**8 Hrs.**

Charging Infrastructure

Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone, EV Charger Integration with Solar Power Plant.

UNIT – V	**8 Hrs.**

Latest trends:

Battery charging infrastructure, including fast, wireless, and innovative charging technologies; the development of public and private networks; integration with renewable energy sources; advancements in charging protocols and global standards; and prospects and challenges in scaling the infrastructure

Mode of Teaching:

Text Books:

1. James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK, Electric Vehicle Technology Explained
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Reference Books:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

Subject Code	Name of the Subject	L	T	P	C
	ADVANCED CONTROL SYSTEMS	3	0	0	3

	Course Educational Objectives	
CEO1	Understand various power generation methods and their role in the Indian energy landscape	
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.	
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.	
COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	8 Hrs.
State Space Analysis State Space Representation – Canonical forms – Controllable canonical form – Observable canonical form - Jordan Canonical Form - Solution of state equation – State transition matrix.	
UNIT – II	**8 Hrs.**
Controllability - Observability and Design of Pole Placement Tests for controllability and observability for continuous time systems – Time varying case – Minimum energy control – Time invariant case – Principle of duality – Controllability and observability form Jordan canonical form and other canonical forms – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement.	
UNIT – III	**8 Hrs.**
Nonlinear Systems Introduction to nonlinear systems - Types of nonlinearities. Introduction to phase–plane analysis - Singular points; Describing function - basic concepts - Describing functions of non- linearities.	
UNIT – IV	**8 Hrs.**
Stability analysis by Lyapunov Method	
Stability in the sense of Lyapunov – Lyapunov's stability and Lyapunov's instability theorems – Direct method of Lyapunov for the linear and nonlinear continuous time autonomous systems.	
UNIT – V	**8 Hrs.**
Calculus of Variations Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints –Euler lagrangine equation.	
Mode of Teaching:	
Text Books: 1. Modern Control Engineering – by K. Ogata - Prentice Hall of India - 3rd edition - 1998. 2. Automatic Control Systems by B.C. Kuo - Prentice Hall Publication.	
Reference Books: 1. Modern Control System Theory – by M. Gopal - New Age International Publishers - 2nd edition - 1996 2. Control Systems Engineering by I.J. Nagarath and M.Gopal - New Age International (P) Ltd. 3. Digital Control and State Variable Methods – by M. Gopal - Tata Mc Graw–Hill Companies - 1997. 4. Systems and Control by Stainslaw H. Zak - Oxford Press - 2003. 5. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.	

Subject Code	Name of the Subject	L	T	P	C
	AI APPLICATIONS TO ELECTRICAL ENGINEERING	3	0	0	3

	Course Educational Objectives
CEO1	Understand various power generation methods and their role in the Indian energy landscape
CEO2	Analyze the economic factors influencing the efficiency and cost-effectiveness of power plants.
CEO3	Calculate and compare the unit costs of solar and wind energy under different scenarios.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze different energy sources and their applications, along with key performance indicators.	4
CO2	Evaluate the construction, operation, and types of nuclear reactors, including site selection and layout considerations for Nuclear power plants.	5
CO3	Examine the principles of hydroelectric power generation, focusing on site selection, hydrology, turbine operation, and essential plant elements.	4
CO4	Investigate thermal power station components, circuits, and operations, emphasizing site selection, steam turbine functionality, and the draft system.	4
CO5	Calculate the unit cost of solar and wind power, considering various influencing factors and comparing cost-effectiveness through real-world case studies.	3
CO6	Integrate knowledge of power generation methods, site selection, operational principles, and economic considerations.	6

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction Artificial Neural Networks (ANN) – Humans and computers – Biological neural networks – ANN Terminology – Models of Artificial neuron – activation functions – typical architectures – biases and thresholds – learning strategy(supervised - unsupervised and reinforced) – Neural networks learning rules. Single layer feed forward neural networks: concept of pattern and its types - perceptron training and classification using Discrete and Continuous perceptron algorithms– linear separability- XOR function.	
UNIT – II	**8 Hrs.**
Multi-layer feed forward networks Generalized delta rule– Back Propagation algorithm– Radial Basis Function (RBF) network - Kohonen's self-organizing feature maps (KSOFM) - Learning Vector Quantization (LVQ) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.	
UNIT – III	**8 Hrs.**
Classical Sets and Fuzzy Sets	
Introduction to classical sets- properties - Operations and relations - Fuzzy sets - Operations - Properties - Fuzzy relations - Cardinalities - Membership functions.	
UNIT – IV	**8 Hrs.**
Fuzzy Logic Modules Fuzzification - Membership value assignment - development of rule base and decision making system - Defuzzification to crisp sets - Defuzzification methods.	
UNIT – V	**8 Hrs.**

Applications

Neural network applications: Load flow studies - load forecasting - reactive power control. Fuzzy logic applications: Economic load dispatch - speed control of DC motors - single area and two area load frequency control.

Mode of Teaching:

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda - Jaico Publishing House - 1997.
2. Neural Networks - Fuzzy logic - Genetic algorithms: synthesis and applications by Rajasekharanand Pai – PHI Publication.

Reference Books:

1. Artificial Neural Network – B.Yegnanarayana - PHI - 2012.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc - 1997.
3. Introduction to Neural Networks using MATLAB 6.0 – S N Sivanandam - SSumathi - S N Deepa TMGH
4. Introduction to Fuzzy Logic using MATLAB – S N Sivanandam - SSumathi - S N Deepa Springer - 2007.

Subject Code	Name of the Subject	L	T	P	C
	Introduction to Machine Learning	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to Machine Learning with Python Introduction to Machine Learning, basic terminology, Types of Machine Learning and Applications, Using Python for Machine Learning: Installing Python and packages from the Python Package Index, Introduction to NumPy, SciPy, matplotlib and scikitlearn, Tiny application of Machine Learning.	
UNIT – II	**8 Hrs.**
Supervised Learning Types of Supervised Learning, Supervised Machine Learning Algorithms: k-Nearest Neighbors, Linear Models, Naive Bayes Classifiers, Decision Trees, Ensembles of Decision Trees, Kernelized Support Vector Machines, Uncertainty Estimates from Classifiers.	
UNIT – III	**8 Hrs.**
Unsupervised Learning Types of Unsupervised Learning, challenges, Preprocessing and scaling, Dimensionality Reduction, Feature Extraction, Manifold Learning, Clustering: K-Means Clustering, Agglomerative Clustering, DBSCAN, Comparing and Evaluating Clustering Algorithms.	
UNIT – IV	**8 Hrs.**
Representing Data and Engineering Features Categorical Variables, Binning, Discretization, Linear Models, Trees, Interactions and Polynomials, Univariate Nonlinear Transformations, Automatic Feature Selection. Parameter Selection with Preprocessing, Building Pipelines, The General Pipeline Interface.	
UNIT – V	**8 Hrs.**
Working with Text Data (Data Visualization) Types of Data Represented as Strings, Example Application: Sentiment Analysis of Movie Reviews, Representing Text Data as a Bag of Words, Stop Words, Rescaling the Data with tf-idf, Investigating Model Coefficients, Approaching a Machine Learning Problem, Testing Production Systems, Ranking, Recommender Systems and Other kinds of Learning.	
Mode of Teaching:	
Text Books: 1. Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Muller & Sarah Guido, Orielly Publications, 2019. 2. Python Machine Learning, Sebastian Raschka & Vahid Mirjalili, 3rd Edition, 2019. 3. Building Machine Learning Systems with Python, Luis Pedro Coelho, Willi Richert, 2nd Edition, 2015.	
Reference Books: **1.** Machine Learning, Tom M. Mitchell, Mc Graw-Hill Publication, 2017	

Subject Code	Name of the Subject	L	T	P	C
	CLOUD COMPUTING WITH AWS	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction of Cloud Computing: What is Cloud Computing, How it works, Types of Cloud, Goals & Challenges, Leveraging Cloud Computing, Cloud Economics and Total Cost of Ownership	
UNIT – II	**8 Hrs.**
Cloud Service Models Software as a Service (SaaS): Introduction, Challenges in SaaS Model, SaaS Integration Services, Advantages and Disadvantages. Infrastructure As a Services (IaaS): Introduction, Virtual Machines, VM Migration Services, Advantages and Disadvantages. Platform As a service (PaaS): Introduction, Integration of Private and Public Cloud, Advantages and Disadvantages.	
UNIT – III	**8 Hrs.**
Virtualization and Abstraction: What is Virtualization and how abstraction is provided in cloud? Advantages and Disadvantages, Types of Hypervisor, and Load balancing.	
UNIT – IV	**8 Hrs.**
Amazon Web Services: Getting started with AWS, AWS Compute, Storage, and Networking, AWS Security, Identity, and Access Management, AWS Database Options, AWS Elasticity and Management Tools	
UNIT – V	**8 Hrs.**
Architecting on AWS Introduction to System Design: AWS Essentials Review and System Design for High Availability, Automation and Serverless Architectures: Event-Driven Scaling, Well-Architected Best Practices: Security, Reliability, Performance Efficiency, Cost Optimization and Deployment and Implementation: Design Patterns and Sample Architectures	
Mode of Teaching:	
Text Books: 1. Judith Hurwitz, R Bloor, M.Kanfman, F.Halper "Cloud Computing for Dummies", Wiley India Edition, First Edition 2. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley Publication, 2011	
Reference Books: 1. Tim Mather, SubraKumara swamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'ReillyMedia Inc, 2009 2. Mickey Iqbal 2010, " IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach", MC Press 3. Frank H. P. Fitzek, Marcos D. Katz, "Mobile Clouds: Exploiting Distributed Resources in Wireless, Mobile and Social Networks", Wiley Publications, ISBN: 978-0-470- 97389-9, Jan 2014.	

Subject Code	Name of the Subject	L	T	P	C
	Basics of Quantum Computing	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs**
Introduction: Introduction to Essential Linear Algebra: Some Basic Algebra, Matrix Math, Vectors and Vector Spaces, Set Theory. Complex Numbers: Definition of Complex Numbers, Algebra of Complex Numbers, Complex Numbers Graphically, Vector Representations of Complex Numbers, Pauli Matrice, Transcendental Numbers.	
UNIT – II	**8 Hrs**
Basic Physics for Quantum Computing: The Journey to Quantum, Quantum Physics Essentials, Basic Atomic Structure, Hilbert Spaces, Uncertainty, Quantum States, Entanglement. **Basic Quantum Theory**: Further with Quantum Mechanics, Quantum Decoherence, Quantum Electrodynamics, Quantum Chromodynamics, Feynman Diagram Quantum Entanglement and QKD, Quantum Entanglement, Interpretation, QKE.	
UNIT – III	**8 Hrs.**
Quantum Architecture: Further with Qubits, Quantum Gates, More with Gates, Quantum Circuits, The D-Wave Quantum Architecture. Quantum Hardware: Qubits, How Many Qubits Are Needed? Addressing Decoherence, Topological Quantum Computing, Quantum Essentials.	
UNIT – IV	**8 Hrs.**
Quantum Algorithms: What Is an Algorithm? Deutsch's Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Algorithm, Grover's Algorithm.	
UNIT – V	**8 Hrs**
Current Asymmetric Algorithms: RSA, Diffie-Hellman, Elliptic Curve. The Impact of Quantum **Computing on Cryptography:** Asymmetric Cryptography, Specific Algorithms, Specific Applications.	
Mode of Teaching:	
Text Books: 1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press 2. Dr. Chuck Easttom, Quantum Computing Fundamentals, Pearson	
Reference Books: 1. Quantum Computing for Computer Scientists by Noson S. Yanofsky and Mirco A. Mannucci 2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. Basic Concepts. Vol. Basic Tools and Special Topics, World Scientific. 3. Pittenger A. O., An Introduction to Quantum Computing Algorithms.	

Subject Code	Name of the Subject	L	T	P	C
	Blockchain technologies	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Fundamental concepts of Blockchain technology. history and evolution of Blockchain, types of Blockchain (public, private, consortium, and hybrid), block structure and chain formation. basics of cryptography, hash functions and digital signatures, and diverse applications of Blockchain across various industries.	
UNIT – II	**8 Hrs.**
Architecture and components of Blockchain systems. various elements such as nodes, ledgers, wallets, and transactions of a Blockchain network. consensus algorithms like Proof of Work (PoW) and Proof of Stake (PoS), the role and operation of smart contracts, the development of decentralized applications (dApps), and the security aspects to Blockchain networks.	
UNIT – III	**8 Hrs.**
Popular Blockchain platforms and the tools used in Blockchain development. Ethereum and its smart contract functionality, Hyperledger Fabric, Bitcoin's underlying Blockchain, and other platforms like Ripple and EOS. Truffle, Remix, Ganache, and MetaMask.	
UNIT – IV	**8 Hrs.**
Use cases and industry applications of Blockchain. Blockchain and is transforming financial services, supply chain management, healthcare, and the public sector by enhancing transparency, security, and efficiency. Emerging trends such as NFTs, the Metaverse, and the integration of Blockchain with IoT.	
UNIT – V	**8 Hrs.**
Challenges and future trends in Blockchain technology, scalability, interoperability, and regulatory challenges. Environmental impact of Blockchain. Future developments in Blockchain technology	
Mode of Teaching:	
Text Books: 1. Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, Apress edition: 1st Edition (2017) 2. Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, Packt Publishing, 3rd Edition (2020)	
Reference Books: 1. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley, 1st Edition (2020) 2. Blockchain: Blueprint for a New Economy, Melanie Swan, O'Reilly Media, 1st Edition (2015)	

R2023
[2023-27]

VIII Semester [Fourth Year]
B. Tech in Electrical Engineering

S.N.	Category	Course Code	Course title	Hours/week			C	CIA	SEE
				L	T	P			
1	PE	23BELPE4801*	Professional Elective – V	3	0	0	3		
2	PE	23BELPE4802*	Professional Elective – VI	3	0	0	3		
3	OE	23BELOE4801*	Open Elective – IV	3	0	0	3		
PRACTICAL / SESSIONAL									
4	PST	23BELPW48101	Major Project	0	0	12	6		
			TOTAL	9	0	12	15		
			Cumulative Total	120	4	100	164		

Professional Elective – V		
	Course Code	Course title
1	23BELPE48011	Utilization of Electrical Energy
2	23BELPE48012	Flexible Alternating Current Transmission Systems
3	23BELPE48013	Neural Networks and Fuzzy Logic
4	23BELPE48014	Testing and Commissioning of Electrical Equipment

Professional Elective – VI		
	Course Code	Course title
1	23BELPE48021	Energy Auditing, Conservation and Management
2	23BELPE48022	EHV AC Transmission
3	23BELPE48023	Computer-Aided Electrical Drawing
4	23BELPE48024	Energy Storage Systems

Open Elective – IV		
	Course Code	Course title
1	23BELOE48011	Hydrogen Energy and Fuel Cells
2	23BELOE48012	Big Data Analytics
3	23BELOE48013	Deep Learning Techniques
4	23BELOE48014	Web Development

Subject Code	Name of the Subject	L	T	P	C
	UTILIZATION OF ELECTRICAL ENERGY	3	0	0	3

	Course Educational Objectives
CEO1	Understand electric heating and welding principles and methods, including AC and DC welding systems.
CEO2	Gain fundamental knowledge of illumination, covering laws, photometry, light sources, and lighting design.
CEO3	Develop the ability to analyze and apply electric traction systems and calculate related performance metrics.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Describe the electric heating and welding methods with AC and DC welding systems.	2
CO2	Explain the fundamentals of illumination, including laws of illumination, photometry, and light sources.	2
CO3	Analyze the electric traction system, track electrification, traction motors, and braking methods.	4
CO4	Calculate tractive effort, power, and specific energy consumption for electric traction.	3
CO5	Compare and evaluate different energy storage technologies, including thermal, electrical, magnetic, and chemical systems, and their applications.	5
CO6	Integrate electric heating, welding, illumination, traction, and energy storage knowledge to solve engineering problems in modern electrical systems.	6

SYLLABUS

UNIT – I	**14Hrs**
ELECTRIC HEATING& WELDING Advantages and methods of electric heating, resistance heating induction heating and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding	
UNIT – II	**14Hrs**
ILLUMINATION FUNDAMENTALS Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and floodlighting, LED lighting	
UNIT – III	**14 Hrs.**
ELECTRIC TRACTION – I System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostatic braking and regenerative braking. Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.	
UNIT – IV	**8 Hrs.**
ELECTRIC TRACTION-II	
Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and braking retardation, adhesive weight and coefficient of adhesion.	

UNIT – V	
Introduction to Energy Storage Systems Need For Energy Storage - Types of Energy Storage-Thermal - Electrical - Magnetic And Chemical Storage Systems - Comparison of Energy Storage Technologies-Applications.	
Mode of Teaching:	
Text Books: 1. Utilization of Electric Energy – by E. Openshaw Taylor - Orient Longman. 2. Art & Science of Utilization of electrical Energy – by Partab - Dhanpat Rai& Sons. 3. Thermal energy storage systems and applications"-by Ibrahim Dincer and Mark A.Rosen. John Wiley and Sons 2002.	
Reference Books: 1. Utilization of Electrical Power including Electric drives and Electric traction – by N.V.Suryanarayana - New Age International (P) Limited - Publishers - 1996. 2. Generation - Distribution and Utilization of electrical Energy – by C.L. Wadhwa - New Age International (P) Limited - Publishers - 1997.	

Subject Code	Name of the Subject	L	T	P	C
	Flexible AC Transmission Systems	3	0	0	3

	Course Educational Objectives
CEO1	Understand the principles of power flow in AC systems and the role of FACTS technology in enhancing system stability and controllability.
CEO2	Learn the operation and applications of Voltage Source Converters (VSC) and Current Source Converters (CSC) in power systems.
CEO3	Assess the effectiveness of shunt, series, and combined compensators in improving power system stability and performance.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Analyze the principles of power flow in AC systems, considering loading limits and the role of controllable parameters in FACTS technology.	4
CO2	Explain the operation and characteristics of Voltage Source Converters (VSC) and Current Source Converters (CSC),	2
CO3	Assess the functions of shunt compensators, including VAR generators, SVC, and STATCOM.	5
CO4	Evaluate the effectiveness of series compensators in improving transient stability and damping power oscillations.	5
CO5	Describe the operational principles of combined compensators such as UPFC and IPFC and their applications in transmission line control.	2
CO6	Summarize the overall impact of FACTS controllers, including shunt, series, and combined compensators, on the stability and controllability of power systems.	2

SYLLABUS

UNIT – I	**14Hrs**

Introduction to FACTS

Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers – Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.

UNIT – II	**14Hrs**

Voltage source and Current source converters

Voltage source converter (VSC) – Single phase full-wave bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full-wave bridge converter - Transformer connections for 12 pulse operation.

Current Source Converter (CSC)-Three–phase current source converter – Comparison of current source converter with voltage source converter.

UNIT – III	**14 Hrs.**

Shunt Compensators

Objectives – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – Improvement of transient stability – Power oscillation damping.

Variable Impedance Type VAR Generator: Thyristor Switched/Controlled Reactor (TSR/TCR) – Thyristor Switched Capacitor (TSC) – Fixed Capacitor–Thyristor Controlled Reactor (FC-TCR) - Thyristor Switched Capacitor and Thyristor Controlled Reactor (TSC–TCR) - Switching Converter type VAR generator.

Principle of operation and comparison of SVC and STATCOM.

UNIT – IV	8 Hrs.
Series Compensators Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. Variable Impedance type series compensators – GTO Thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC) and Thyristor Controlled Series Capacitor (TCSC) - Switching Converter type Series Compensation – Static Synchronous Series Compensator.	
UNIT – V	
Combined Compensators Schematic and basic operating principles of unified power flow controller (UPFC) and Interline power flow controller (IPFC) – Controller applications of transmission lines.	
Mode of Teaching:	
Text Books: **1.** Understanding FACTS" N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:—Standard Publications, 2001.	
Reference Books: 1. "Flexible ac transmission system (FACTS)" Edited by Yong Hue Song and Allan T Johns, Institution of Electrical Engineers, London. 2. Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R. Mohan Mathur and Rajiv K.Varma, Wiley.	

Subject Code	Name of the Subject	L	T	P	C
	NEURAL NETWORKS AND FUZZY LOGIC	3	0	0	3

	Course Educational Objectives
CEO1	Provide students with a solid understanding of Artificial Neural Networks (ANN) and their key components.
CEO2	Enable students to design and apply feed-forward neural networks and advanced ANN paradigms for problem-solving.
CEO3	Develop student's skills in fuzzy logic and its integration into intelligent decision-making systems.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Describe the fundamental concepts of Artificial Neural Networks, including models, activation functions, and learning strategies,	2
CO2	Implement single-layer feed-forward neural networks, focusing on perceptron training, classification algorithms, and the analysis of linear separability.	3
CO3	Apply advanced ANN paradigms, including multi-layer feed-forward networks, backpropagation, and RBF networks.	3
CO4	Explain classical and fuzzy set theory principles, including operations, relations, and the role of membership functions in fuzzy logic systems.	2
CO5	Design fuzzy logic modules encompassing fuzzification, rule-based development, and defuzzification methods for decision-making applications.	6
CO6	Integrate ANN and fuzzy logic knowledge to analyze and develop systems that address real-world challenges through intelligent computation.	4

SYLLABUS

UNIT – I	**14Hrs**
Introduction Artificial Neural Networks (ANN) – Humans and Computers – Biological Neural Networks – ANN Terminology – Models of Artificial Neuron – activation functions – typical architectures – biases and thresholds – learning strategy(supervised - unsupervised and reinforced) – Neural networks learning rules.	
UNIT – II	**14Hrs**
Feed Forward Networks: Single Layer Feed Forward Neural Networks: Concept of Pattern And Its Types - Perceptron Training and Classification Using Discrete and Continuous Perceptron Algorithms– Linear Separability- XOR Function.	
UNIT – III	**14 Hrs.**
ANN Paradigms Multi-layer feed forward networks –Generalized delta rule– Back Propagation algorithm – Radial Basis Function (RBF) network - Kohonen's self-organizing feature maps (KSOFM) – Bidirectional Associative Memory (BAM).	
UNIT – IV	**8 Hrs.**
Classical and Fuzzy Sets Introduction to classical sets- properties - Operations and relations; Fuzzy sets - Operations - Properties - Fuzzy relations - Cardinalities - Membership functions.	
UNIT – V	
Fuzzy Logic Modules Fuzzification - Membership value assignment - development of rule base and decision-making system - Defuzzification to crisp sets - Defuzzification methods**.**	
Mode of Teaching:	

Text Books:

1. S N Deepa and S N Sivanandam, 'Principles of Soft Computing', 2nd Edition, Wiley,
2. Kosko, B, 'Neural Networks and Fuzzy systems: A Dynamical Approach to Machine Intelligence, Prentice Hall India Ltd, New Delhi-2004
3. Timmothy J Ross, 'Fuzzy Logic with Engineering Applications', John Willey and Sons, West Sussex, Enland-2005

Reference Books:

1. **Jack M Zurada,** 'Introduction to Artificial Neural Networks', PWS Publishing Co Boston-2002
2. **Klir G J & Folger T A, '**Fuzzt Sets, Uncertainty and Information', Prentice hall of India Pvt. Ltd, ND-2008

Subject Code	Name of the Subject	L	T	P	C
	TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENTS	3	0	0	3

	Course Educational Objectives
CEO1	To understand and apply safety management practices in electrical systems, focusing on earthing methods and procedures.
CEO2	To develop skills for installing, inspecting, and commissioning electrical equipment according to industry standards
CEO3	To perform and analyze tests on electrical equipment, ensuring compliance with Indian Standards and effective maintenance practices.

COs	**Upon successful completion of this course, students should be able to:**	**BTL**
CO1	Explain the safety management principles in electrical systems, including earthing methods, earth resistance, and earthing procedures.	2
CO2	Manage electrical equipment installation on-site, including inspection, storage, alignment, and technical reporting, to ensure successful project execution.	3
CO3	Perform transformers and electrical equipment testing according to Indian Standards, covering essential tests, troubleshooting, and maintenance procedures.	3
CO4	Install and commission rotating electrical machines, focusing on protection, cooling systems, site testing, and maintenance per industry standards.	3
CO5	Commission transmission lines, understanding the components and processes involved in AC and HVDC systems, including substation and GIS technologies.	3
CO6	Integrate safety, installation, testing, and commissioning practices to effectively manage electrical engineering projects with compliance and efficiency.	6

SYLLABUS

UNIT – I	**14Hrs**

Safety Management:

Objectives, Safety Management during Operation and Maintenance, Clearance and Creepages, Electric Shock, need of Earthing, different methods of Earthing, factors affecting the Earth Resistance, methods of measuring the Earth Resistance, Equipment Earthing and System Grounding, Earthing Procedure - Building installation, Domestic appliances, Industrial premises, Earthing of substation, generating station and overhead line.

UNIT – II	**14Hrs**

Installation of Electrical Equipment:

Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Foundation of Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, Technical report, Inspection, storage and handling of transformer, switchgear and motors.

UNIT – III	14 Hrs.
Testing of Transformer, Plant and Equipment:	
General Requirements for Type, Routine and Special Tests, Measurement of winding resistance; Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss; Measurement of no-load loss and current; Measurement of insulation resistance; Dielectric tests; Temperature-rise, insulation and HV test, dielectric absorption, switching impulse test. testing of Current Transformer and Voltage Transformer, power transformer, distribution transformer, CVT and special transformer concerning Indian Standard (IS). Drying out procedure for transformer. PI index, Commissioning steps for transformer, Troubleshooting & Maintenance of transformer. [Ref: IS 2026:Part_1-10-Power Transformers: Methods of Test; IS 13956:1994Testing Transformers]	
UNIT – IV	**8 Hrs.**
Installation and Commissioning of Rotating Electrical Machines: Degree of protection, cooling system, degree of cooling with IP- IC code (brief discussion), enclosures, rating of industrial rotating electric machine, installation, commissioning and protection of induction motor and rotating electric machine, drying out of electric rotating machine, insulation resistance measurement, site testing and checking, care, services and maintenance of motors, commissioning of synchronous generator, protection and automation of synchronous generator, synchronous motor, D.C. generator and motor concerning Indian Standard (IS).	
UNIT – V	
Transmission line: Commissioning of A.C transmission line and HVDC transmission, galvanize steel structure, towers and insulator for transmission and distribution line, tower footing resistance, substation equipment, bus bar system, power cable, low power control cable, Contactor, GIS (gas insulated substation).	
Mode of Teaching:	
Text Books: 1. Rao, S., "Testing, commissioning, operation and maintenance of electrical equipment", 6/E., Khanna Publishers, New Delhi 2. Paul Gill, "Electrical power equipment maintenance and testing", CRC Press, 2008.	
Reference Books: 1. Singh Tarlok, "Installation, commissioning and maintenance of Electrical equipment", S.K. Kataria and Sons, New Delhi, 2. Philip Kiameh, "Electrical Equipment Handbook: Troubleshooting and Maintenance", McGraw-Hill, 2003. 3. Relevant Indian Standards (IS Code) and IEEE Standards for-Installation, maintenance and commissioning of electrical equipments /machines.	

Subject Code	Name of the Subject	L	T	P	C
	Energy Auditing, Conservation and Management	3	0	0	3

	Course Educational Objectives
CEO1	Equip students with the knowledge and tools to conduct energy audits in various industries and buildings
CEO2	Develop students' ability to manage energy programs effectively, including planning, monitoring, and reporting
CEO3	Enable students to analyze and implement energy-efficient technologies and perform economic evaluations for energy conservation

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Describe the principles and tools of energy auditing, including types, indices, and conservation schemes, and their application in industries and buildings	2
CO2	Organize an energy management program by planning, monitoring, and reporting while identifying the qualities and functions of an energy manager	3
CO3	Analyze the efficiency and characteristics of energy-efficient motors and lighting systems and conduct energy audits to optimize their performance	4
CO4	Evaluate methods for power factor improvement, and understand the use of energy instruments for monitoring and enhancing energy efficiency.	5
CO5	Perform economic analysis for energy management, applying methods like lifecycle costing, payback period, and return on investment calculations for energy-efficient solutions	3
CO6	Demonstrate a comprehensive understanding of energy audit, management principles, energy-efficient technologies, and economic evaluation to implement effective energy conservation strategies	5

SYLLABUS

UNIT – I	**8 Hrs.**
BASIC PRINCIPLES OF ENERGY AUDIT: Energy audit- definitions - concept - types of audit - energy index - cost index - pie charts – Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry - thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017)	
UNIT – II	**8 Hrs.**
Energy Management Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions – language - Questionnaire – checklist for top management.	
UNIT – III	**8 Hrs.**
Energy-Efficient Motors and Lighting Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. Lighting system design and practice - lighting control - lighting energy audit.	
UNIT – IV	**8 Hrs.**
Power Factor Improvement And Energy Instruments	
Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on p.f - p.f motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.	
UNIT – V	**8 Hrs.**

Economic Aspects and Their Computation

Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

Text Books:

gy management by W.R.Murphy&G.Mckay Butter worth - Heinemann publications - 1982.
gy management hand book by W.CTurner - John wiley and sons - 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995
2. Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

Subject Code	Name of the Subject	L	T	P	C
	EHV AC TRANSMISSION	3	0	0	3

	Course Educational Objectives
CEO1	Understand EHV AC transmission systems' necessity, advantages, and challenges for practical applications.
CEO2	Analyze voltage gradients, electrostatic fields, and corona effects to assess their impact on EHV AC transmission
CEO3	Apply voltage control techniques and traveling wave theory to optimize EHV AC transmission systems

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Identify EHV AC transmission systems' necessity, advantages, and challenges, including power handling capacity.	1
CO2	Analyze the voltage gradients and electrostatic fields in EHV AC systems, focusing on charge-potential relationships.	4
CO3	Evaluate the impact of corona effects on EHV AC transmission, including power loss, audible noise, and radio interference.	5
CO4	Calculate the electrostatic field of EHV AC lines and assess its impact on living beings and infrastructure, incorporating principles of traveling wave theory.	3
CO5	Apply voltage control methods in EHV AC systems, including power circle diagrams, synchronous condensers, and series compensation.	3
CO6	Integrate knowledge of line parameters, voltage gradients, corona effects, electrostatic fields, and voltage control methods to optimize EHV AC transmission networks.	6

SYLLABUS

UNIT – I	**8 Hrs.**

Preliminaries:

Necessity of EHV AC transmission – advantages and problems–power handling capacity and line losses- mechanical considerations – resistance of conductors – properties of bundled conductors – bundle spacing and bundle radius- Examples. Line and ground reactive parameters: Line inductance and capacitances – sequence inductances and capacitances – modes of propagation – ground return – Examples.

UNIT – II	**8 Hrs.**

Voltage gradients of conductors:

Electrostatics – field of sphere gap – field of line changes and properties – charge – potential relations for multi-conductors – surface voltage gradient on conductors – distribution of voltage gradient on sub-conductors of bundle – Examples.

UNIT – III	**8 Hrs.**

Corona effects:

Power loss and audible noise (AN) – corona loss formulae – charge voltage diagram – generation, characteristics - limits and measurements of AN – relation between 1-phase and 3-phase AN levels – Examples. Radio interference (RI) - corona pulses generation, properties, limits – frequency spectrum – modes of propagation – excitation function – measurement of RI, RIV and excitation functions – Examples.

UNIT – IV	**8 Hrs.**

Electro static field:

Electrostatic field: calculation of electrostatic field of EHV/AC lines – effect on humans, animals and plants – electrostatic induction in un-energized circuit of double-circuit line – electromagnetic interference-Examples. Traveling wave theory: Traveling wave expression and solution- source of excitation- terminal conditions- open circuited and short-circuited end- reflection and refraction coefficients-Lumped parameters of distributed lines generalized constants-No load voltage conditions and charging current.

UNIT – V	8 Hrs.
Voltage control: Power circle diagram and its use – voltage control using synchronous condensers – cascade connection of shunt and series compensation – sub synchronous resonance in series capacitor – compensated lines – static VAR compensating system.	
Text Books: **1.** EHVAC Transmission Engineering by R. D. Begamudre, New Age International (p) Ltd. **2.** "HVAC and DC Transmission", 3rd edition , Khanna Publishers, 2001 by S. Rao.	
Reference Books: **1.** Rakosh Das Begamudre ,"Extra high voltage AC Transmission Engineering"-Wiley Eastem LTD. **2.** Edison,"EHV Transmission line"-Electric institution.	

Subject Code	Name of the Subject	L	T	P	C
	Computer Aided Engineering Drawing	3	0	0	3

	Course Educational Objectives
CEO1	Understand engineering drawing conventions, including BIS standards, and use of drafting software.
CEO2	Applyorthographic and isometric projection techniques to represent geometric shapes and engineering components.
CEO3	Develop skills in creating lateral surfaces and multidisciplinary drawings using drafting tools and software.

COs	***Upon successful completion of this course, students should be able to:***	**BTL**
CO1	Understand the significance of engineering drawing, BIS conventions, and basic drafting techniques, including freehand sketching and computer-aided drafting.	2
CO2	Apply the principles of orthographic projections to represent points, lines, and planes using geometric shapes in the first quadrant.	3
CO3	Create orthographic projections of right regular solids, including prisms, pyramids, cylinders, and frustums, based on their placement in the horizontal plane.	6
CO4	Develop and convert isometric projections into orthographic views, emphasizing isometric scales and projection techniques.	6
CO5	Design the development of lateral surfaces for solids like prisms, cylinders, and pyramids, applying these skills to practical engineering tasks.	6
CO6	Integrate engineering drawing principles to produce multidisciplinary drawings and diagrams, including mechanical, electrical, and building plans, using appropriate software.	6

SYLLABUS

UNIT – I	**8 Hrs.**

Introduction:

Significance of Engineering drawing, BIS Conventions of Engineering Drawing, Free hand sketching of engineering drawing, Scales. Introduction to Computer Aided Drafting software, Co-ordinate system and reference planes HP, VP, RPP & LPP of 2D/3D environment. Selection of drawing sheet size and scale. Commands and creation of Lines, coordinate points, axes, polylines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet and curves. Orthographic Projections of Points, Lines and Planes: Introduction to Orthographic projections: Orthographic projections of points in 1st and 3rd quadrants. Orthographic projections of lines (Placed in First quadrant only). Orthographic projections of planes viz triangle, square, rectangle, pentagon, hexagon, and circular laminae (Placed in First quadrant only using change of position method). Application on projections of Lines & Planes

UNIT – II	**8 Hrs.**

Orthographic Projection of Solids:

Orthographic projection of right regular solids (Solids Resting on HP only): Prisms & Pyramids (triangle, square, rectangle, pentagon, hexagon), Cylinders, Cones, Cubes &Tetrahedron. Projections of Frustum of cone and pyramids

UNIT – III	8 Hrs.
Isometric Projections: Isometric scale, Isometric projection of hexahedron (cube), right regular prisms, pyramids, cylinders, cones and spheres. Isometric projection of combination of two simple solids. Conversion of simple isometric drawings into orthographic views. Problems on applications of Isometric projections of simple objects / engineering components. Introduction to drawing views using 3D environment	
UNIT – IV	**8 Hrs.**
Development of Lateral Surfaces of Solids: Development of lateral surfaces of right regular prisms, cylinders, pyramids and cones resting with base on HP only. Development of lateral surfaces of their frustums and truncations. Problems on applications of development of lateral surfaces like funnels and trays. Problems on applications of development of lateral surfaces of transition pieces connecting circular duct and rectangular duct	
UNIT – V	**8 Hrs.**
Multidisciplinary Applications & Practice: Free hand Sketching; True free hand, Guided Free hand, Roads, Buildings, Utensils, Hand tools & Furniture's etc Drawing Simple Mechanisms; Bicycles, Tricycles, Gear trains, Ratchets, two-wheeler cart &Four-wheeler carts to dimensions etc Electric Wiring and lighting diagrams; Like, Automatic fire alarm, Call bell system, UPS system, Basic power distribution system using suitable software Basic Building Drawing; Like, Architectural floor plan, basic foundation drawing, steel structures- Frames, bridges, trusses using Auto CAD or suitable software, Electronics Engineering Drawings- Like, Simple Electronics Circuit Drawings, practice on layers concept. Graphs & Charts: Like, Column chart, Pie chart, Line charts, Gantt charts, etc. using Microsoft Excel or any suitable software.	

Text Books:

1. S.N. Lal, & T Madhusudhan:, Engineering Visulisation, 1st Edition, Cengage,Publication
2. Parthasarathy N. S., Vela Murali, Engineering Drawing, Oxford University Press,2015.

Reference Books:

1. Bhattacharya S. K., Electrical Engineering Drawing, New Age International publishers, second edition 1998, reprint2005.
2. Chris Schroder, Printed Circuit Board Design using AutoCAD, Newnes,1997.
3. K S Sai Ram Design of steel structures, , Third Edition byPearson Nainan p kurian Design of foundation systems, Narosapublications

Subject Code	Name of the Subject	L	T	P	C
	Energy Storage Systems	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to energy storage in power systems (6) Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store (CS) and charge–discharge control system (CDCS), Econometric model of storage system.	
UNIT – II	**8 Hrs.**
Overview on Energy storage technologies: Thermal energy: General considerations -Storage media- Containment- Thermal energy storage in a power plant, Potential energy: Pumped hydro-Compressed Air, Kinetic energy: Mechanical- Flywheel , Power to Gas : Hydrogen - Synthetic methane	
UNIT – III	8 Hrs.
Electrochemical energy : Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy-Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors), Electromagnetic energy (Super conducting Magnetic Energy Storage), Comparative analysis, Environmental impacts of different technologies.	
UNIT – IV	**8 Hrs.**
Energy storage and renewable power sources Types of renewable energy sources: Wave - Wind – Tidal – Hydroelectric - Solar thermal technologies and Photovoltaics, Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources	
UNIT – V	**8 Hrs.**
Energy storage Applications: Smart grid, Smart microgrid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), Management and control hierarchy of storage systems - Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Battery SCADA, Hybrid energy storage systems: configurations and applications	
Text Books: **1.** A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-184919-219-4),2011. **2.** Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.	
Reference Books: **1.** Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010. **2.** Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) -a National Laboratory of the U.S. Department of Energy. **3.** P. Nezamabadi and G. B. Gharehpetian, "Electrical energy management of virtual power plants in distribution networks with renewable energy resources and energy storage systems", IEEE Power Distribution Conference, 2011.	

Subject Code	Name of the Subject	L	T	P	C
	Hydrogen Energy and Fuel Cell	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
HYDROGEN ENERGY: Introduction to hydrogen economy, production, storage and transportation systems, hydrogen from fossil fuels, electrolysis of water, thermo chemical cycles, transmission and infrastructure requirements, safety and environmental impacts, economics of transition to hydrogen systems	
UNIT – II	**8 Hrs.**
FUEL CELLS: Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages, different types of fuel cells and applications, characteristics, Nernst equation, relation of the fuel consumption versus current output.	
UNIT – III	8 Hrs.
FUEL CELL DESIGN AND PERFORMANCE Stoichiometric coefficients and utilization percentages of fuels and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and serial connection, over-potential and polarizations, DMFC operation scheme, general issues-water flooding and water management, polarization in PEMFC	
UNIT – IV	**8 Hrs.**
FUEL CELLS -APPLICATION AND ECONOMICS: Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells	
UNIT – V	**8 Hrs.**
SAFETY MEASURES: Properties of hydrogen associated with hazards, classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, codes and standards, utilization of hydrogen in various sectors, global status and future directions	
Text Books: R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, Hydrogen Review 2021, IEA (2021), Paris, https://www.iea.org/reports/global-hydrogen-review-	
Reference Books: 1. AgataGodula-Jopek, Hydrogen Production by Electrolysis, Wiley-VCH, Germany, 2015 2. Tzimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. "Hydrogen storage: state-of-the-art and future perspective. Netherlands": European Communities, 2003. 3. Michael Hirscher, "Handbook of Hydrogen Storage", Wiley-VCH, 2010.	

Subject Code	Name of the Subject	L	T	P	C
	BIG DATAANALYTICS	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to Big Data, Big Data Characteristics, Types of BigData, Traditional Versus Big Data Approach, Technologies Availablefor Big Data, Infrastructure for Big Data, Use of Data Analytics, Big Data Challenges.Types of Data Sources Sampling, Types of Data Elements ,Visual Data Exploration and Exploratory Statistical Analysis, Missing Values, Outlier Detection and Treatment, Standardizing Data, Categorization, Weights of Evidence Coding, Variable Selection, Segmentation	
UNIT – II	**8 Hrs.**
Predictive Analytics: Target Definition, Linear Regression, Logistic Regression, Decision Trees, Neural Networks, Support Vector Machines, Ensemble Methods, Multiclass Classification Techniques, Evaluating Predictive Models Descriptive Analytics: Association Rules, Sequence Rules, Segmentation Survival Analysis: Survival Analysis Measurements, Kaplan Meier Analysis, Parametric Survival Analysis, Proportional Hazards Regression, Extensions of Survival Analysis Models, Evaluating Survival Analysis Models.	
UNIT – III	8 Hrs.
Big Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -, Data Serialization.HDFS-Overview, Installation and Shell, Java API; Hive Architecture and Installation, Comparison with Traditional Database, HiveQL Querying Data, Sorting And Aggregating, Map Reduce Scripts, Joins & Sub queries, HBase concepts, Advanced Usage, Schema Design, Advance Indexing, PIG, Zookeeper , how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.	
UNIT – IV	**8 Hrs.**
Introduction to Data Analysis with Spark, Downloading Spark and Getting Started, Programming with RDD, Spark SQL, Spark Streaming. Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, Document-Oriented, principles of schema design,	
UNIT – V	**8 Hrs.**
Constructing queries on Databases, collections and Documents, MongoDB Query Language Apache Spark GraphX: Property Graph, Graph Operator, SubGraph, Triplet, Neo4j: Modeling data with Neo4j, Cypher Query Language: General clauses, Read and Write clauses. Big Data Visualization with D3.js, Kibana and Grafana.	
Text book: **1.** Bart Baesens , Analytics in a Big Data World: The Essential Guide to DataScience and its Applications, ,Wiley, 2014	
Reference book: 1. Xyz Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014. 2. Chuck Lam, Hadoop in Action, December, 2010. 3. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press. 4. I.H. Witten and E. Frank, Data Mining: Practical Machine learning tools and techniques	

Subject Code	Name of the Subject	L	T	P	C
	DEEP LEARNING TECHNIQUES	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Fundamentals of Deep Learning Artificial Intelligence, History of Machine learning: Probabilistic Modeling, Early Neural Networks, Kernel Methods, Decision Trees, Random forests and Gradient Boosting Machines, **Fundamentals of Machine Learning:** Four Branches of Machine Learning, Evaluating Machine learning Models, Overfitting and Underfitting.	
UNIT – II	**8 Hrs.**
Introducing Deep Learning Biological and Machine Vision, Human and Machine Language, Artificial Neural Networks, Training Deep Networks, Improving Deep Networks.	
UNIT – III	**8 Hrs.**
Neural Networks Anatomy of Neural Network, Introduction to Keras: Keras, TensorFlow, Theano and CNTK, Setting up Deep Learning Workstation, Classifying Movie Reviews: Binary Classification, Classifying newswires: Multiclass Classification.	
UNIT – IV	**8 Hrs.**
Convolutional Neural Networks Nerual Network and Representation Learing, Convolutional Layers, Multichannel Convolution Operation, **Recurrent Neural Networks:** Introduction to RNN, RNN Code, PyTorch Tensors: Deep Learning with PyTorch, CNN in PyTorch.	
UNIT – V	**8 Hrs.**
Interactive Applications of Deep Learning Machine Vision, Natural Language processing, Generative Adversial Networks, Deep Reinforcement Learning. **Deep Learning Research:** Autoencoders**,** Deep Generative Models: Boltzmann Machines Restricted Boltzmann Machines, Deep Belief Networks.	

Textbooks:

1. Deep Learning- Ian Goodfellow, Yoshua Bengio and Aaron Courvile, MIT Press, 2016
2. Deep Learning with Python - Francois Chollet, Released December 2017, Publisher(s): Manning Publications, ISBN: 9781617294433
3. Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence - Jon Krohn, Grant Beyleveld, Aglaé Bassens, Released September 2019, Publisher(s): Addison-Wesley Professional, ISBN: 9780135116821
4. Deep Learning from Scratch - Seth Weidman, Released September 2019, Publisher(s): O'Reilly Media, Inc., ISBN: 9781492041412

Reference book:

1. Artificial Neural Networks, Yegnanarayana, B., PHI Learning Pvt. Ltd, 2009.
2. Matrix Computations, Golub, G.,H., and Van Loan,C.,F, JHU Press,2013.
3. Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-Hill Education, 2004.

Subject Code	Name of the Subject	L	T	P	C
	WEB DEVELOPMENT	3	0	0	3

SYLLABUS

UNIT – I	**8 Hrs.**
Introduction to PHP: Declaring variables, data types, arrays, strings, operations, expressions, control structures, functions, Reading data from web form controls like Text Boxes, radio buttons, lists etc., Handling File Uploads, Connecting to database (My SQL as reference), executing simple queries, handling results, Handling sessions and cookies. File Handling in PHP: File operations like opening, closing, reading, writing, appending, deleting etc. on text and binary files, listing directories.	
UNIT – II	**8 Hrs.**
Client side Scripting: Introduction to JavaScript: JavaScript language – declaring variables, scope of variables functions, event handlers (on click, on submit etc.), Document Object Model, Form validations. Simple AJAX applications.	
UNIT – III	**8 Hrs.**
XML: Introduction to XML, Defining XML tags, their attributes and values, Document type definition, XML Schemas, Document Object model, XHTML Parsing XML Data - DOM and SAX parsers in java	
UNIT – IV	**8 Hrs.**
Introduction to Servlets: Common Gateway Interface (CGI), Lifecycle of a Servlets, deploying a Servlets, The Servlets API, Reading Servlets parameters, Reading initialization parameters, Handling Http Request & Responses, Using Cookies and sessions, connecting to a database using JDBC.	
UNIT – V	**8 Hrs.**
Introduction to JSP: The Anatomy of a JSP Page, JSP Processing, Declarations, Directives, Expressions, Code Snippets, implicit objects, Using Beans in JSP Pages, Using Cookies and session tracking, connecting to database in JSP..	
Text book: 1. Web Technologies, Uttam K Roy, Oxford University Press 2. The Complete Reference PHP – Steven Holzner, Tata McGraw-Hill	
Reference book: 1. Web Programming, building internet applications, Chris Bates 2nd edition, Wiley Dremtech 2. Java Server Pages – Hans Bergsten, SPD O'Reilly 3. Java Script, D.Flanagan, O'Reilly, SPD. Beginning Web Programming-Jon Duckett WROX. 4. Programming world wide web, R.W. Sebesta. Fourth Edition, Pearson. 5. Internet and World Wide Web – How to program, Dietel and Nieto, Pearson	

Head of the Department
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