Curriculum
2023

B. Tech.
Electrical & Electronics Engineering

(Duration of Study : 4 years)

GMRIT
Training Tomorrow's Engineers Today

Department of Electrical & Electronics Engineering
GMR Institute of Technology
Rajam, Andhra Pradesh
(An Autonomous Institute Affiliated to JNTU Kakinada, AP)
NBA Accredited and NAAC Accredited

The Vision of GMRIT

- To be among the most preferred institutions for engineering and technological education in the country
- An institution that will bring out the best from its students, faculty and staff – to learn, to achieve, to compete and to grow – among the very best
- An institution where ethics, excellence and excitement will be the work religion, while research, innovation and impact, the work culture

The Mission of GMRIT

- To turnout disciplined and competent engineers with sound work and life ethics
- To implement outcome based education in an IT-enabled environment
- To encourage all-round rigor and instill a spirit of enquiry and critical thinking among students, faculty and staff
- To develop teaching, research and consulting environment in collaboration with industry and other institutions

Department Vision

To be a most preferred Electrical & Electronics Engineering department of learning for students and teachers alike, with dual commitment to research and serving students in an atmosphere of innovation and critical thinking.

Department Mission

- To provide high-quality education in Electrical & Electronics Engineering, to prepare the graduates for a rewarding career in Electrical & Electronics Engineering and related industries, in tune with evolving needs of the industry.
- To prepare the students to become thinking professional and good citizens who would apply their knowledge critically and innovatively to solve professional and societal problems.

Program Educational Objectives (PEOs)

- **PEO1:** Graduates with ability to solve core engineering problems through continuous self-paced learning in tune with changing technologies
- **PEO2:** Reinforce engineering skills, critical thinking and problem-solving skills in professional engineering practices and deal with socio-economical, technical and business challenges
- **PEO3:** Nurture professionalism with soft skills, managerial & leadership skills and ethical values.

Program Outcomes (POs):

Engineering graduate will be able to:

PO 1: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. (Engineering knowledge)

PO 2: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (Problem analysis)

PO 3: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. (Design/development of solutions)

PO 4: 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. (Conduct investigations of complex problems)

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

PO 6: 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. (The engineer and society)

PO 7: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. (Environment and sustainability)

PO 8: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. (Ethics)

PO 9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. (Individual and team work)

PO 10: Communicate effectively on complex engineering activities with the engineering community and with 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. (Communication)

PO 11: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. (Project management and finance)

PO 12: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. (Life-long learning)

Program Specific Outcomes (PSOs):

Engineering graduate will be able to:

PSO#1: Utilize statistics, transformation methods, discrete mathematics and application of differential equations in analysing and design of electrical/electronic systems. (Program Specific)

PSO#2: Analyze, design and implement control of electrical systems in any problem/application of electrical/electronic (s) engineering. (Program Specific)

Department of Electrical & Electronics Engineering

Minimum Credits to be earned: 160 (for Regular Students)
127 (for Lateral Entry Students)

S.No	Course Code	Course Name	POs	Contact Hours			
				L	T	P	C
First Semester							
1	23CYX01	Chemistry	1,12	3	0	0	3
2	23MAX01	Linear Algebra& Calculus	1	3	0	0	3
3	23BEX01	Basic Electrical and Electronics Engineering	1,2,PSO1	3	0	0	3
4	23BEX03	Introduction to Programming	1,2,12	3	0	0	3
5	23BEX04	Engineering Graphics	1,5,10	2	0	2	3
6	23CYX03	Chemistry Lab	1,4	0	0	2	1
7	23BEX05	Electrical & Electronics Engineering Workshop	1,4,5	0	0	3	1.5
8	23BEX07	Computer Programming Lab	4	0	0	3	1.5
9	23HSX12	CCA (NSS/NCC/Community Service)		0	0	1	0.5
			Total	**14**		**11**	**19.5**
Second Semester							
1	23MAX02	Differential Equations and Vector Calculus	1	3	0	0	3
2	23PYX02	Engineering Physics	1,2,12	3	0	0	3
3	23HSX01	Communicative English	10,12	2	0	0	2
4	23BEX02	Basic Civil & Mechanical Engineering	1,2,3,6,7,8,12	3	0	0	3
5	23EE201	Electrical Circuit Analysis-I	1,2,PSO1	3	0	0	3
6	23HSX02	Communicative English Lab	10,12	0	0	2	1
7	23PYX02	Engineering Physics Lab	4,9,11	0	0	2	1
8	23BEX08	IT workshop	1,2,3,4,9,12	0	0	2	1
9	23BEX06	Engineering Workshop	1,9,12	0	0	3	1.5
10	23EE202	Electrical Circuits Lab	5	0	0	3	1.5
11	23HSX11	Health and Wellness, Yoga and Sports		0	0	1	0.5
			Total	**14**	**-**	**13**	**20.5**
Third Semester							
1	23MA302	Engineering Mathematics III	1,4,5	3	-	2	4
2	23EE302	DC Machines and Transformers	1,2	3	-	-	3
3	23EE303	Electrical Circuit Analysis-II	1,2,PSO1	3	-	-	3
4	23EE304	Electromagnetic Field Theory	1,2	3	-	-	3
5	23EE305	Measurements and Instrumentation	1,2,3	3	-	-	3
6	23EE306	Semiconductor Devices and Circuits	1,2, 3, 4,5	3	-	2	4
7	23EE307	DC Machines Lab	4	-	-	3	1.5
8	23EE308	Python Programming lab	4,5	-	-	3	1.5
9	23ESX01	Employability Skills I	1,2,5,8,10,12	-	-	2	-
			Total	**18**	**-**	**12**	**23**
Fourth Semester							
1	23EE401	AC Machines	1,2	3	-	-	3
2	23EE402	Linear and Digital Integrated Circuits	1,2,4	3	-	2	4
3	23EE403	Power Electronics	2,3,PSO1,PSO2	3	-	-	3
4	23EE404	Power Generation, Transmission and Distribution	1, 2,6	3	-	-	3
5	23EE405	Signals and Systems Theory	3,5,PSO1	3	-	-	3
6	23EE406	AC Machines Lab	4	-	-	3	1.5
7	23EE407	Measurements and Instrumentation Lab	4	-	-	3	1.5
8	23ESX01	Employability Skills I	1,2,5,8,10,12	-	-	2	2

			Total	**15**	**-**	**10**	**21**
Fifth Semester							
1	23IT306	Object Oriented Programming through Java	1,2,3,4,5	3	-	2	4
2	23EE502	Control Systems	2,3,4,5,PSO1,PSO2	3	-	2	4
3	23EE503	Electrical Drives	2,3,PSO2	3	-	-	3
4	23EE504	Power System Protection	2,3,PSO2	3	-	-	3
5		Elective I (Professional Elective)		3	-	-	3
6		Elective II (Open Elective I)		3	-	-	3
7	23EE507	Power Electronics and Drives Lab	4,5	-	-	3	1.5
8	23TPX01	Term Paper	1,4,10,12	-	-	3	1.5
9	23ESX02	Employability Skills II	1,2,5,8,10,12	-	-	2	-
10	23SIX01	Summer Internship I	1,2,8,10,12				1
			Total	**18**	**-**	**12**	**24**
Sixth Semester							
1	23HSX10	Engineering Economics and Project Management	11,12	3	-	-	3
2	23EE602	Power System Analysis and Control	2,3,PSO1,PSO2	3	-	-	3
3	23EE603	Utilization of Electrical Energy	3,6,7,8	3	-	-	3
4		Elective III (Professional Elective)		3	-	2	4
5		Elective IV (Open Elective II)		3	-	-	3
6	23EE606	Power Systems Lab	4,5	-	-	3	1.5
7	23MPX01	Mini Project	1 to12,PSO1,PSO2	-	-	3	1.5
8	23ESX02	Employability Skills II	1,2,5,8,10,12	-	-	2	2
9	23ATX01	Environmental Studies	1,3,6,7	-	-	-	-
10	23ATX02	Professional Ethics and Human Values	-----	-	-	-	-
11	23ATX03	Indian Knowledge Systems	12	-	-	-	-
			Total	**15**	**-**	**10**	**21**
Seventh Semester							
1		Elective V (Professional Elective)		3	-	-	3
2		Elective VI (Professional Elective)		3	-	-	3
3		Elective VII (Open Elective III)		3	-	-	3
4	23SIX02	Summer Internship II	1,2,5,6,10,12	-	-	-	1
5	23PWX01	Project	1 to 12,PSO1,PSO2	-	-	16	8
			Total	**9**	**-**	**16**	**18**
Eighth Semester							
1		Elective VIII (Professional Elective)		-	-	-	3
2		Elective IX (Open Elective IV)		-	-	-	2
3	23FIX01	Full Semester Internship (FSI)	1,2,5,8,9,10,PSO1, PSO2	-	-	-	8
			Total	**-**	**-**	**-**	**13**

List of Electives

Language Electives							
No.	**Course Code**	**Course**	**Pos**	**Contact Hours**			
				L	**T**	**P**	**C**
1	23HSX03	Advanced Communicative English	10,12	2	-	-	2
2	23HSX04	Communicative German		2	-	-	2
3	23HSX05	Communicative French		2	-	-	2
4	23HSX06	Communicative Japanese		2	-	-	2
5	23HSX07	Communicative Spanish		2	-	-	2
6	23HSX08	Communicative Korean		2	-	-	2
7	23HSX09	Communicative Hindi		2	-	-	2
Elective I							
Career Path I, II, III and Other Core Electives							
1	23EEC11	Electrical Vehicle Technologies	2,3,12,PSO2	3	-	-	3
2	23EEC21	Green Energy Technologies	2,3,12	3	-	-	3
3	23EEC31	Micro and Smart Grid Technologies	2,3,12,PSO2	3	-	-	3
4	23EE017	Electrical Machine Design	2,3	3	-	-	3
5	23EE018	High Voltage DC Transmission	2,3,PSO2	3	-	-	3
6	23EE019	Special Electrical Machines	2,3,PSO2	3	-	-	3
7		MOOCs		-	-	-	3
Elective III							
Career Path I, II, III and Other Core Electives							
1	23EEC12	Electric Vehicle Drive Train Systems	2,3,12,PSO2	3	-	2	4
2	23EEC22	Power Electronic Applications to Green Energy Systems	2,3,5,12,PSO2	3	-	2	4
3	23EEC32	Control and Instrumentation of Smart Grid Systems	3,4,5,12,PSO2	3	-	2	4
4	23EE020	Advanced Control Systems	2,3,4,5,PSO1,PSO2	3	-	2	4
5	23EE021	Discrete Signal Processing	2,3,4,5,PSO1,PSO2	3	-	2	4
6	23EE009	Machine Modelling and Steady State Analysis	2,3,4,5	3	-	2	4
Elective V							
Career Path I, II, III and Other Core Electives							
1	23EEC13	Battery Management Systems	2, 12, PSO1,PSO2	3	-	-	3
2	23EEC23	Hybrid Renewable Energy Systems Design	2,12, PSO1,PSO2	3	-	-	3
3	23EEC33	Communication and Security in Smart Grid	2,12, PSO1,PSO2	3	-	-	3
4	23EE010	Electrical Distribution Systems	2,3,PSO2	3	-	-	3
5	23EC401	Analog and Digital Communications	1,2	3	-	-	3
6	23IT304	Database Management Systems	1,2,3,12	3	-	-	3
7		MOOCs		-	-	-	3
Elective VI							
1	23EE011	Energy Audit, Conservation and Managaement	2,3,12,PSO2	3	-	-	3
2	23EE012	Microprocessors and Microcontroller Interfacing	2,3,10,PSO2	3	-	-	3
3	23EE013	Programmable Logic Controllers	2,3,PSO2	3	-	-	3
		MOOCs		-	-	-	3
Elective VIII (Professional Elective)							
1	23EE014	Power System Deregulation	2,3,PSO2	-	-	-	3
2	23EE015	Power System Dynamics & Control	2,3,PSO2	-	-	-	3
3	23EE016	High Voltage Engineering	2,3,PSO2	-	-	-	3
4		MOOCs		-	-	-	3
B. Tech. (Honors)							
Domain I: AI in Electrical and Electronics Engineering							
01	23EEH11	Computational Intellegence in Electrical Engineering	1,2,12,PSO2	4	-	-	4
02	23EEH12	Data analytics in Electrical Engineering	1,2,12	4	-	-	4
03	23EEH13	Internet of Things in Electrical Engineering	1,2,12, PSO1	4	-	-	4
04	23EEH14	Introduction to Smart Cities	1,2,12, PSO2	4	-	-	4
Domain II: Power Systems							
01	23EEH21	Design and Layout of Power Systems	1,2,3,8	4	-	-	4
02	23EEH22	Distributed Generation Technologies	1,2,6,7,8, PSO2	4	-	-	4
03	23EEH23	Distribution System Planning and Automation	2,3,6, PSO2	4	-	-	4

04	23EEH24	Power Quality	2,3,8, PSO2	4	-	-	4
Domain III: Control Systems							
01	23EEH31	Adaptive Control Systems	2,3,PSO1,PSO2	4	-	-	4
02	23EEH32	Introduction to Autonomous Vehicles	2,3, PSO2	4	-	-	4
03	23EEH33	Introduction to Robust Control Systems	2,3, PSO1,PSO2	4	-	-	4
04	21EEH34	Optimal Control Systems	2,3, PSO1,PSO2	4	-	-	4
Domain IV: Power Electronics and Drives							
01	23EEH41	Advanced Power Electronics	2,3, PSO1,PSO2	4	-	-	4
02	23EEH42	Flexible AC Transimission Systems	2,3, PSO1	4	-	-	4
03	23EEH43	Power Electronic Control of DC Drives	2,3,PSO2	4	-	-	4
04	23EEH44	Power Electronic Control of AC Drives	2,3,PSO2	4	-	-	4
B. Tech. (Minors)							
Energy Science & Technology							
01	23CHM11	Foundation of Energy Science and Technology	1,2,3,5,7,12	4	-	-	4
02	23CHM12	Energy Generation from Waste	1,2,3,4,5	4	-	-	4
03	23CHM13	Energy Storage Systems	1,2,3,6,7	4	-	-	4
04	23CHM14	Hydrogen Energy and Fuel Cells	1,2,3,7	4	-	-	4
Nano Science & Technology							
01	23CHM21	Introduction and Characterization of Nano Materials	1,2,3,7	4	-	-	4
02	23CHM22	Carbon Nanostructures and Applications	1,3,4,5	4	-	-	4
03	23CHM23	Energy, Environment & Biomedical Nanotechnology	1,2,3,7	4	-	-	4
04	23CHM24	Industrial Applications of Nano Technology	2,3,5,7	4	-	-	4
Environmental Engineering							
01	23CEM11	Watershed Management	6,7	4	-	-	4
02	23CEM12	Industrial Pollution Control and Engineering	3,6,7,12	4	-	-	4
03	23CEM13	Solid and Hazardous Waste Management	1,3,6,7	4	-	-	4
04	23CEM14	Ecology and Environmental Assessment	1,3,6,7	4	-	-	4
Artificial Intelligence & Machine Learning							
01	23CSM11	Fundamentals of AI & Machine Learning	1,12	4	-	-	4
02	23CSM12	Feature Engineering for Machine Learning	1,2,3	4	-	-	4
03	23CSM13	Exploratory Data Analytics	1,4	4	-	-	4
04	23CSM14	Deep Learning	1,2,4	4	-	-	4
Cyber Security							
01	23CSM21	Fundamentals of Security	1,2	4	-	-	4
02	23CSM22	Management of Information Security	3,6,7	4	-	-	4
03	23CSM23	Cyber Security	1,3,4	4	-	-	4
04	23CSM24	Cloud Security	2,3	4	-	-	4
Data Science & Analytics							
01	23CSM31	Data Cleaning	2,3,4	4	-	-	4
02	23CSM32	Data Engineering	1,2,3,4	4	-	-	4
03	23CSM33	Text Analytics	1,2,4	4	-	-	4
04	23CSM34	Social Network and Semantic Analysis	2,4	4	-	-	4
Computer Systems Programming							
01	23CSM41	Programming Fundamentals	1,2,3	4	-	-	4
02	23CSM41	Data Structures & Algorithms	1,2,3,4	4	-	-	4
03	23CSM41	Fundamentals of Databases	1,4	4	-	-	4
04	23CSM41	Fundamentals of Computer Networks & Operating Systems	1,2,3	4	-	-	4
Digital IC Design							
01	23ECM11	Fundamentals of VLSI Design	1,2,3	4	-	-	4
02	23ECM12	Digital Design using HDL	1,2,3	4	-	-	4
03	23ECM13	FPGA Technology	1,2	4	-	-	4
04	23ECM14	Analog and Mixed Signal Design	1,2	4	-	-	4
Industrial Automation							
01	23ECM21	Microcontrollers and Interfacing	1,2,3	4	-	-	4
02	23ECM22	Sensors and Data Acquisition System	1,2	4	-	-	4
03	23ECM23	Fundamentals of Labview	1,2	4	-	-	4
04	23ECM24	Medical Robotics	1,2,3	4	-	-	4

Communications and Networking							
01	23ECM31	Principles of Communications	1,2	4	-	-	4
02	23ECM32	Coding Theory and Practice	1,2	4	-	-	4
03	23ECM33	Ad-hoc and Wireless Sensor Networks	1,2,3	4	-	-	4
04	23ECM34	Fundamentals of Multimedia Networking	1,2,3	4	-	-	4
Avionics							
01	23ECM41	Principles of Aerodynamics	1,2	4	-	-	4
02	23ECM42	Aircraft Electrical Systems	1,2	4	-	-	4
03	23ECM43	Aircraft Instrument Systems	1,2	4	-	-	4
04	23ECM44	Aircraft Communication and Navigational Systems	1,2	4	-	-	4
Geographic Information System							
01	23ECM51	Sensors and Sensing Technology	1,2	4	-	-	4
02	23ECM52	Geographic Information Systems	1,2	4	-	-	4
03	23ECM53	Digital Image Processing	1,2	4	-	-	4
04	23ECM54	Lidar Systems	1,2	4	-	-	4
Cloud Application Development							
01	23ITM11	Introduction to Cloud Computing	6,7,12	4	-	-	4
02	23ITM12	Introduction to Web Development with HTML, CSS, JavaScript	1,2,3,9,12	4	-	-	4
03	23ITM13	Developing Cloud Native Applications	5,8,10	4	-	-	4
04	23ITM14	Introduction to Cloud Computing	6,7,12	4	-	-	4
Robotics and Automation							
01	23MEM11	Introduction to Robotics	1,2,3	4	-	-	4
02	23MEM12	Drives and Sensors	1,2,3,4	4	-	-	4
03	23MEM13	Control Systems for Robotics	1,2,3,4	4	-	-	4
04	23MEM14	Machine Learning for Robotics	2,5	4	-	-	4
Industrial Systems Engineering							
01	23MEM21	Industrial Management	1,10,11,12	4	-	-	4
02	23MEM22	Fundamentals of Operations Research	1,2,3,5	4	-	-	4
03	23MEM23	Enterprise Resource Planning	1,2,3,5,11,12	4	-	-	4
04	23MEM24	Production Planning and Control	1,2,3,5,11,12	4	-	-	4

Open Electives

No.	Course Code	Course	L	T	P	Credits
1	23OO411	Principles of Data Science	3	-	-	3
2	23OO412	Data Science for Engineering Applications	3	-	-	3
3	23OO413	Computer Vision	3	-	-	3
4	23OO414	Deep Learning for Computer Vision	2	-	-	2
5	23OO421	Fundamentals of Machine Learning	3	-	-	3
6	23OO422	Fundamentals of Deep Learning	3	-	-	3
7	23OO423	Principles of Reinforcement Learning	3	-	-	3
8	23OO424	Affective Computing	2	-	-	2
9	23OO431	Aerodynamics, Flight Controls and Aircraft Systems	3	-	-	3
10	23OO432	Aircraft Materials and Structures	3	-	-	3
11	23OO433	Aircraft Gas Turbine Engines	3	-	-	3
12	23OO434	Avionics Systems	2	-	-	2
13	23OO111	Principles of Internet of Things	3	0	0	3
14	23OO112	IoT Applications in Building Automation	3	0	0	3
15	23OO113	IoT for Structural Health Monitoring	3	0	0	3
16	23OO114	AI and ML for Data Analytics	2	0	0	2
17	23OO121	Fundamentals of Data Science and Statistics	3	-	-	3
18	23OO122	Database Management Systems for Data Science	3	-	-	3
19	23OO123	Data Mining and Exploratory Data Analysis	3	-	-	3
20	23OO124	Predictive Analytics and Machine Learning	2	-	-	2
21	23OO131	Entrepreneurship Theory and Practice	3	0	0	3
22	23OO132	Design Thinking and Innovation Management	3	0	0	3
23	23OO133	Product Design and Innovation	3	0	0	3
24	23OO134	Business Analytics for Entrepreneurship	2	0	0	2
25	23OO141	Introduction to Smart Cities	3	-	-	3
26	23OO142	Sustainable Urban Planning and Development	3	-	-	3

27	23O0143	Remote Sensing and GIS for Smart Cities	3	-	-	3
28	23O0144	Intelligent transportation systems	2	-	-	2
29	23O0311	Principles of Safety Management	3	-	-	3
30	23O0312	Occupational Health and Industrial Hygiene	3	-	-	3
31	23O0313	Safety in Engineering Industries	3	-	-	3
32	23O0314	Reliability Engineering and Integrated Management Systems	2	-	-	2
33	23O0321	Fundamentals of Artificial Intelligence and Machine Learning	3	-	-	3
34	23O0322	Fundamentals of Data Science	3	-	-	3
35	23O0323	Applications of Machine Learning	3	-	-	3
36	23O0324	Data Science for Mechanical Systems	2	-	-	2
37	23O0331	Entrepreneurship Theory and Practice	3	-	-	3
38	23O0332	Design Thinking and Innovation Management	3	-	-	3
39	23O0333	Product Design &Innovation	3	-	-	3
40	23O0334	Business Analytics for Entrepreneurship	2	-	-	2
41	23O0211	Fundamentals of VLSI Design	3	-	-	3
42	23O0212	Digital Design with Verilog	3	-	-	3
43	23O0213	Verification Using System Verilog	3	-	-	3
44	23O0214	VLSI Design Flow: RTL to GDS	2	-	-	2
45	23O0511	Data Wrangling and Preprocessing	3	-	-	3
46	23O0512	Data Visualization Techniques	3	-	-	3
47	23O0513	Time Series Data Analysis and Modelling	3	-	-	3
48	23O0514	AI for Business Intelligence	2	-	-	2
49	23O0001	Disaster Management	3	-	-	3
50	23O0002	Electrical Installation, Safety and Auditing	3	-	-	3
51	23O0003	Fundamentals of Optimization Techniques	3	-	-	3
52	23O0004	Sensors for Engineering Applications	3	-	-	3
53	23O0005	Fundamentals of Artificial Intelligence	3	-	-	3
54	23O0006	Energy Conversion and Storage Devices	3	-	-	3
55	23O0007	Fundamentals of Multimedia	3	-	-	3
56	23O0008	Nano Materials and Technology	3	-	-	3
57	23O0009	Fundamentals of Data Science	3	-	-	3
58	23O0010	Air Pollution and Environmental Impact Assessment	3	-	-	3
59	23O0011	Renewable Energy Sources	3	-	-	3
60	23O0012	Principles of Entrepreneurship	3	-	-	3
61	23O0013	Electronics for Agriculture	3	-	-	3
62	23O0014	Industrial Safety and Hazard Management	3	-	-	3
63	23O0015	Basics of Cloud Computing	3	-	-	3
64	23O0016	Advanced Numerical Techniques	3	-	-	3
65	23O0017	Functional Materials and Applications	3	-	-	3
66	23O0018	Solid Waste Management	3	-	-	3
67	23O0019	Fundamentals of Electrical Vehicle Technology	3	-	-	3
68	23O0020	Industrial Engineering and Management	3	-	-	3
69	23O0021	Interfacing and Programming with Arduino	3	-	-	3
70	23O0022	Industrial Ecology for Sustainable Development	3	-	-	3
71	23O0023	Fundamentals of Mobile Computing	3	-	-	3
72	23O0024	Advanced Materials of Renewable Energy	3	-	-	3
73	23O0025	Applied Linear Algebra for Engineers	3	-	-	3
74	23O0026	Green Buildings	3	-	-	3
75	23O0027	Sustainable Energy	3	-	-	3
76	23O0028	Total Quality Management	3	-	-	3
77	23O0029	Communication Technologies	3	-	-	3
78	23O0030	Applications of Artificial Intelligence	3	-	-	3
79	23O0031	Green Technologies	3	-	-	3
80	23O0032	Human Computer Interaction	3	-	-	3
81	23O0033	Handling of Industrial waste and wastewater	3	-	-	3
82	23O0034	Robotics and Automation	3	-	-	3
83	23O0035	Introduction to IoT	3	-	-	3
84	23O0036	Fundamentals of Image processing	3	-	-	3
85	23O0037	Fundamentals of Data Acquisition systems	3	-	-	3

86	23O0038	Airport Operations Management	3	-	-	3
87	23O0039	Fundamentals of Embedded Systems	3	-	-	3
88	23O0040	Remote Sensing and GIS	3	-	-	3
89	23O0041	Big Data Analytics	3	-	-	3
90	23O0042	Fundamentals of Cyber Security	3	-	-	3
91	23O0043	Smart Cities	3	-	-	3
92	23O0044	Nano Materials and Thin Film Technology	3	-	-	3
93	23O0045	Cloud computing	3	-	-	3
94	23O0046	Ethical Hacking				
95	23O0047	Fundamentals of Web Development	3	-	-	3
96	23O0048	Business Intelligence & Analytics	3	-	-	3
97	23O0049	Introduction To Industry 4.0 And Industrial IoT	3	-	-	3
98	23O0050	Introduction to NLP	3	-	-	3
99	23O0051	Data Structure and Algorithms using Java	3	-	-	3
100	23O0052	The Joy of Computing Using Python	3	-	-	3
101	23O0053	Programming in Modern C++	3	-	-	3
102	23O0054	Data Analytics with python	3	-	-	3
103	23O0055	Safety in Construction	3	-	-	3

GMR Institute of Technology
An Autonomous Institute Affiliated to JNTU-GV

Affiliated to JNTU-GV- Vizianagaram
1st SEMESTER

Pattern-I - A to H Sections				Pattern-II - I to P Sections			
S. No.	**Course Code**	**Course Name**	**Credits**	**S. No.**	**Course Code**	**Course Name**	**Credits**
1	23PYX01	Engineering Physics	3	1	23CYX01 23CYX02	Chemistry (EEE, ECE, CSE, AIML, AIDS, IT) Engineering Chemistry (CE, ME)	3
2	23MAX01	Linear Algebra& Calculus	3	2	23MAX01	Linear Algebra& Calculus	3
3	23BEX01	Basic Electrical and Electronics Engineering	3	3	23BEX02	Basic Civil & Mechanical Engineering	3
4	23BEX03	Introduction to Programming	3	4	23BEX03	Introduction to Programming	3
5	23BEX04	Engineering Graphics	3	5	23HSX01	Communicative English	2
6	23PYX02	Engineering Physics Lab	1	6	23CYX03 23CYX04	Chemistry Lab (EEE, ECE, CSE, AIML, AIDS, IT) Engineering Chemistry Lab (CE, ME)	1
7	23BEX05	Electrical & Electronics Engineering Workshop	1.5	7	23BEX06	Engineering Workshop	1.5
8	23BEX07	Computer Programming Lab	1.5	8	23BEX07	Computer Programming Lab	1.5
9	23BEX08	IT Workshop	1	9	23HSX02	Communicative English Lab	1
				10	23HSX11	ECA (Yoga / Sports)	0.5
				11	23HSX12	CCA (NSS/NCC/Community Service)	0.5
		Total	**20**			**Total**	**20**

2nd SEMESTER

Pattern-I - A to H Sections				Pattern-II - I to P Sections			
S. No.	**Course Code**	**Course Name**	**Credits**	**S. No.**	**Course Code**	**Course Name**	**Credits**
1	23CYX01 23CYX02	Chemistry (EEE, ECE, CSE, AIML, AIDS, IT) Engineering Chemistry (CE, ME)	3	1	23PYX01	Engineering Physics	3
2	23MAX02	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	3	2	23MAX02	DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS	3
3	23BEX02	Basic Civil & Mechanical Engineering	3	3	23BEX01	Basic Electrical and Electronics Engineering	3
4	23ME201 23CS201 23EE201 23EC201 (Branch Specific Theory)	Engineering Mechanics (Civil, Mech) ; Data Structures (CSE, CSE-AI&DS, CSE-AI&ML, IT) ; Electrical Circuit Analysis-1 (EEE); Network Analysis (ECE);	3	4	23ME201 23CS201 23EE201 23EC201 (Branch Specific Theory)	Engineering Mechanics (Civil, Mech) ; Data Structures (CSE, CSE-AI&DS, CSE-AI&ML, IT) ; Electrical Circuit Analysis-1 (EEE); Network Analysis (ECE);	3
5	23HSX01	Communicative English	2	5	23BEX04	Engineering Graphics	3
6	23CYX03 23CYX04	Chemistry Lab (EEE, ECE, CSE, AIML, AIDS, IT) Engineering Chemistry Lab (CE, ME)	1	6	23PYX02	Engineering Physics Lab	1
7	23BEX06	Engineering Workshop	1.5	7	23BEX05	Electrical & Electronics Engineering Workshop	1.5
8	23CE201 23CS202 23EE202 23EC202 23ME202 (Branch Specific Lab)	Engineering Mechanics and Building Practices Lab (Civil); Data Structures Lab (CSE, CSE-AI&DS, CSE-AI&ML, IT); Electrical Circuits Lab (EEE); Network Analysis Lab (ECE); Engineering Mechanics Lab (Mech);	1.5	8	23CE201 23CS202 23EE202 23EC202 23ME202 (Branch Specific Lab)	Engineering Mechanics and Building Practices Lab (Civil); Data Structures Lab (CSE, CSE-AI&DS, CSE-AI&ML, IT); Electrical Circuits Lab(EEE); Network Analysis Lab(ECE); Engineering Mechanics Lab (Mech);	1.5
9	23HSX02	Communicative English Lab	1	9	23BEX08	IT Workshop	1
10	23HSX11	ECA (Yoga / Sports)	0.5				
11	23HSX12	CCA (NSS/NCC/Community Service)	0.5				
		Total	**20**			**Total**	**20**

23PYX01 - ENGINEERING PHYSICS
(Common to all branches of Engineering)

3 0 0 3

Course Outcomes

1. Comprehend the basic principle of diffraction and observe the diffraction pattern in various cases
2. Illustrate the concepts of Interference and polarisation and their applications
3. Understand the space lattices and crystal symmetry
4. Summarize the fundamental concepts of quantum mechanics
5. Explore the properties and applications of dielectric and magnetic materials
6. Demonstrate the conduction process of charge carriers in semiconductors

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					1			1		1		
CO2	3	2					1			1		1		
CO3	3	2					1			1		1		
CO4	3	2					1			1		1		
CO5	3	2					1			1		1		
CO6	3	2					1			1		1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit: I Wave Optics **13 Hours**

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Colours in thin films- Newton's Rings, Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit, double slit & N-slits (Qualitative) – Diffraction Grating - Dispersive power and resolving power of Grating (Qualitative).

Polarization: Introduction -Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism -Half wave and Quarter wave plates

UNIT II Crystallography and X-ray diffraction **10 Hours**

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattices – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC – Miller indices – separation between successive (hkl) planes. *X- ray diffraction*: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue's and powder methods

UNIT III Dielectric and Magnetic **12 Hours**

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector –Relation between the electric vectors - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius-Mossotti equation - complex dilectric constant – Frequency dependence of polarization – dielectric loss

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability – Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials

Unit: IV Quantum Mechanics, Free electron theory and Semiconductors **13 Hours**

Quantum Mechanics: Dual nature of matter – Heisenberg's Uncertainty Principle – Significance and properties of wave function – Schrodinger's time independent and dependent wave equations– Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits and demerits) – Quantum free electron theory – electrical conductivity based on quantum free electron theory - Fermi-Dirac distribution - Density of states - Fermi energy.
Semiconductors: Semiconductors: Formation of energy bands – classification of crystalline solids – Intrinsic semiconductors: Density of charge carriers – Electrical conductivity – Fermi level – Extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein's equation – Hall effect and its applications

Total: 48 hours

Textbooks:

1. A Text book of Engineering Physics - M. N. Avadhanulu, P.G.Kshirsagar& TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).
3. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning

Reference Books:

1. Engineering Physics - Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018.
2. Engineering Physics" - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.
3. Engineering Physics - D.K.Bhattacharya and PoonamTandon, Oxford press (2015).

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	
Understand	50	50	
Apply	10	10	70
Analyze			30
Evaluate			
Create			
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define Polarization of light
2. State Bragg's law of x-ray diffraction
3. Define Bohr magneton
4. List any two merits of classical free electron theory

Understand

1. Draw and explain the variation in intensity in diffraction due to single slit
2. Explain with diagram the Powder method of X-ray diffraction
3. Explain hysteresis behavior of ferromagnetic materials
4. Derive Schrodinger's time dependent wave equation

Apply

1. A parallel beam of light of wavelength 6000 Å is incident on a thin glass plate of refractive index 1.5 such that the angle of refraction into the plate is 50°. Find the least thickness of the glass plate which will appear dark by reflection.
2. Draw and label (1 0 0), (0 2 0), (0 2 2) crystallographic planes.
3. Draw and compare soft and hard magnetic materials based on their hysteresis loops.
4. An electron is confined to a one dimensional potential box of length 2 Å. Calculate the energies corresponding to the second and fourth quantum states in eV.

23CYX01 - CHEMISTRY – EEE, ECE, CSE, IT, AI&ML, AI&DS

3 0 0 3

Course Outcomes

1. Illustrate the Molecular Orbital diagrams for simple diatomic and polyatomic molecules.
2. Identify the applications of super conductors, semi conductors and super capacitors & nano materials.
3. Explain the working of spectroscopy and Chromatography.
4. Explain the properties and applications of polymers & fibres.
5. Estimate the analytes using potentiometric & conductometric titrations and electrochemical sensors
6. Describe the construction and working of electrochemical cells.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1	3					1		
CO2	3	1				1	2					1		
CO3	3	1				1	3					1		
CO4	3	1				1	2					1		
CO5	3	1				1	3					1		
CO6	3	1				1	2					1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Structure and Bonding Models, Modern Engineering materials:

Fundamentals of Quantum mechanics, Schrodinger Wave equation, significance of Ψ (psi) and Ψ^2 (psi square), particle in one dimensional box, molecular orbital theory – bonding in homo- and heteronuclear diatomic molecules – energy level diagrams of O2 and CO, etc. π-molecular orbitals of butadiene and benzene, calculation of bond order.

Semiconductors – Introduction, basic concept, application-Super conductors-Introduction basic concept, applications. Supercapacitors: Introduction, Basic Concept-Classification – Applications **13 Hours**

Unit II

Nano materials & Instrumental methods & applications

Nano materials: Introduction, classification, properties and applications of Fullerenes, carbonnano tubes and Graphines nanoparticles.

Electromagnetic spectrum. Absorption of radiation: Beer-Lambert's law. UV-VisibleSpectroscopy, electronic transition, Instrumentation, IR spectroscopies, fundamental modesand selection rules, Instrumentation. Chromatography-Basic Principle, Classification-HPLC:Principle, Instrumentation and Applications. **10 Hours**

Unit III

Polymer Chemistry & Applications

Introduction to polymers, functionality of monomers, chain growth and step growth, polymerization, coordination polymerization, with specific examples and mechanisms of polymer formation.

Plastics –Thermo and Thermosetting plastics, Preparation, properties and applications of –PVC, Teflon, Bakelite, Nylon-6,6, carbon fibres.

Elastomers–Buna-S, Buna-N–preparation, properties and applications. Conducting polymers – polyacetylene, polyaniline, – mechanism of conduction and applications. Bio-Degradable polymers - Poly Glycolic Acid (PGA), Polyl Lactic Acid (PLA)

Fuel cells, hydrogen-oxygenfuel cell– working of the cells. Polymer Electrolyte Membrane Fuel cells (PEMFC).

16 Hours

Unit IV

Electrochemistry & Applications

Electrochemical sensors – potentiometric sensors with examples, amperometric sensors with examples. Primary cells – Zinc-air battery, Secondary cells –lithium-ion batteries- working of the batteries including cell reactions.

Electrochemical cell, Nernst equation, cell potential calculations and numerical problems, potentiometry-potentiometric titrations (redox titrations), concept of conductivity, conductivity cell, conductometric titrations (acid-base titrations). **09 Hours**

Total: 48 Hours

Textbooks:

1. A Text book of Engineering Physics - M. N. Avadhanulu, P.G.Kshirsagar& TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).
3. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning

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2. Engineering Physics" - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.
3. Engineering Physics - D.K.Bhattacharya and PoonamTandon, Oxford press (2015).

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam
Remember	39	40	
Understand	53	53	
Apply	08	07	50
Analyze			50
Evaluate			
Create			
Total (%)	100	100	100

Sample Question (s)

Remember

1. Write the Schrodinger wave equation?
2. Define nanomaterial with an example
3. Define functionality
4. Write any two applications of PVC

Understand

1. Illustrate the molecular orbital energy level diagram of O_2 molecule
2. Write the classification and applications of carbon nanotubes
3. Illustrate construct and working of Li ion battery
4. What is fuel cell? Explain construction and working of hydrogen-oxygen fuel cell

Apply

1. By using MO rules, draw the π-molecular orbital energy level diagram of 1,3-butadiene
2. Calculate emf of the following cell at 25oC. Given the standard reduction potentials of zinc and copper –0.76 V and +0.37 V respectively. Zn(s) | Zn2+ (0.1M) || Cu2+ (0.001M) | Cu(s).

23CYX02 - ENGINEERING CHEMISTRY – CIVIL, MECH

3 0 0 3

Course Outcomes

1. CO1: Assess the quality of water and its treatment methods
2. CO2: Estimate the potentials for electrochemical cells
3. CO3: Describe corrosion factors and implement prevention methods.
4. CO4: Illustrate the types of polymers and Fuels with applications
5. CO5: Describe the concepts of colloids, micelle and nanomaterials
6. CO6: Explain the uses of refractory materials, lubricants and cements.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1				1	3					1		
CO2	3	1				1	2					1		
CO3	3	1				1	3					1		
CO4	3	1				1	2					1		
CO5	3	1				1	3					1		
CO6	3	1				1	2					1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT I: Water Technology

Soft and hardwater, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen -Boiler troubles –Priming, foaming, scale and sludge, Caustic embrittlement, Industrial water treatment – Specifications for drinking water, Bureau of Indian Standards(BIS) and World health organization(WHO)standards, Ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis

10 Hours

UNIT II: Electrochemistry and Applications

Electrodes –electrochemical cell, Nernst equation, cell potential calculations. Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCad),and lithium ion batteries- working principle of the batteries including cell reactions; Fuel cells-Basic Concepts, the principle and working of hydrogenoxygen Fuel cell. Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electro less plating (Nickel and Copper).

12 Hours

UNIT III: Polymers and Fuel Chemistry

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growthpolymerization. Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications ofpoly styrene. PVC Nylon 6,6 and Bakelite. Elastomers – Preparation, properties and applications of BunaS, Buna N, Thiokol rubbers.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis ofcoal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetanenumberalternativefuels-propane, methanol, ethanol and bio fuel-bio diesel.

10 Hours

UNIT IV: Surface Chemistry and Modern Engineering Materials

Surface Chemistry- Introduction to surface chemistry, colloids, nanometals and nanometal oxides, micelleformation, synthesis of colloids (Braggs Method), adsorption isotherm (Freundlich and Longmuir), BETequation (no derivation).Nano Materials- Chemical and biological methods of preparation of nanometals and metal oxides,stabilization of colloids and nanomaterials by stabilizing agents, applications of colloids and nanomaterials– catalysis, medicine, sensors, etc.Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites,

properties and Engineering applications

Refractories and lubricants- Classification, Properties, Factors affecting the refractory materials andApplications. Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils– Viscosity, Viscosity Index, Flash point, Fire point, Cloud point, saponification and Applications.Building materials- Portland cement, constituents, Setting and Hardening of cement. **16 Hours**

Total: 48 Hours

Textbook (s)

1. P.C. Jain and Monica Jain, Engineering Chemistry,16thEd., DhanpatRai Publishing Company, New Delhi, 2015.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford University Press, 2010.
3. C.N.R. Rao, A. Muller and A.K. Cheetham, Nanomaterials Chemistry: Recent Developments and New Directions, 2010.

Reference (s)

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J. Shaw, Introduction to Colloids and Surface Chemistry, Butterworth-Heineman, 1992.
3. Textbookof Polymer Science, Fred W. BillmayerJr, 3rd Edition

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Exam(%)
Remember	40	40	--
Understand	50	50	-
Apply	10	10	50
Analyze	-	-	50
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define hardness
2. Differentiate between primary and secondary battery
3. Define Octane and cetane number
4. What are the good characteristic properties of good refractory material?

Understand

1. Explain in detail how the hardwater is purified by ion exchange process
2. How the underground buried pipeline is protected by sacrificial anodic protection?
3. Explain the preparation of Nano metal oxide by chemical precipitation method
4. Explain the chemistry involved in setting and hardening of cement

Apply

1. What are different treatment methods for removal of hardness and compare their merits and demerits
2. What are the points are to be taken into account in the construction of a good battery with life?
3. How to get commercial products obtaining from crude oil and list out the byproducts with carbon content, Boiling point and its uses

23MAX01 - LINEAR ALGEBRA & CALCULUS

3 0 0 3

Course Outcomes: At the end of the course, the student will be able to

1. Solve the system of linear equations
2. Construct the eigenvectors of a matrix, use the applications of Cayley Hamilton theorem
3. Identify the nature of the quadratic form using matrix theory
4. Apply Mean value theorems to solve single variable problems.
5. Make use of partial derivatives to solve multivariable problems
6. Utilize multiple integrals to find the area and volume of solids

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								1		
CO2	3	2	3	3								1		
CO3	3	3	3	2								1		
CO4	3	2	2	1								1		
CO5	3	3	2	1								1		
CO6	3	3	3	2								1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT – I

Matrices

Rank of a matrix by echelon form, normal form. Cauchy –Binet formulae (without proof). Inverse of Non- singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method, Gauss Seidel Iteration Method. **12 Hours**

UNIT – II

Linear Transformation and Orthogonal Transformation:

Eigenvalues, Eigenvectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation. **12 Hours**

UNIT – III

Single and Multi-Variable Calculus

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

Partial differentiation: Partial derivatives, total derivatives, chain rule, change of variables, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers. **14 Hours**

UNIT – IV

Multiple Integrals

Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

10 Hours

Total: 48 Hours

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers,2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

Reference Books:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science International Ltd., 2021 (9th reprint).
2. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.

3. Glyn James, Advanced Modern Engineering Mathematics, 5/e, Pearson publishers, 2018.
4. Michael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
5. H. K Das, Er. RajnishVerma, Higher Engineering Mathematics, S. Chand,2021.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment Test (%)
Remember	10	10	-
Understand	40	40	20
Apply	50	50	50
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define rank of a matrix
2. State Cayley-Hamilton theorem
3. State Rolle's theorem
4. State Taylor's theorem

Understand

1. Find the rank of the matrix $A = \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}$ by reducing it to echelon form.
2. Using Cayley-Hamilton theorem find A^4, for $A = \begin{bmatrix} 1 & 2 \\ 2 & -1 \end{bmatrix}$
3. Verify Lagrange's mean value theorem for $(x)^{\frac{3}{4}}$ in [-1,2]
4. Evaluate $\int_0^a \int_0^{\sqrt{a^2-x^2}} \sqrt{a^2 - x^2 - y^2} dxdy$

Apply

1. Utilise Gauss-Jordan method, to find the inverse of the matrix $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ -2 & -4 & -4 \end{bmatrix}$
2. Find the eigen values and the corresponding eigen vectors of $A = \begin{bmatrix} 1 & 2 & -1 \\ 0 & 2 & 2 \\ 0 & 0 & -2 \end{bmatrix}$
3. If $a < b$, prove that $\frac{b-a}{1+b^2} < \tan^{-1} b - \tan^{-1} a < \frac{b-a}{1+a^2}$ using Lagrange's mean value theorem. Deduce that $\frac{5\pi+4}{20} < \tan^{-1} 2 < \frac{\pi+2}{4}$
4. Evaluate $\int_0^\infty \int_0^\infty e^{-(x^2+y^2)} dxdy$ by change into polar coordinates

23BEX01 BASIC ELECTRICAL & ELECTRONICS ENGINEERING
(Common to all branches of Engineering)

3 0 0 3

Course Outcomes

1. Demonstrate the electrical parameters of DC & AC circuits.
2. Illustrate the operation of electrical machines and power plants.
3. Summarize electrical measurements and safety measures
4. Explain the operation of semiconductor devices and their characteristics.
5. Illustrate the operation of rectifiers.
6. Illustrate the number systems, binary codes, and combinational circuits using logic gates.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**1**	**2**			**1**						**3**		
CO2	**2**	**1**	**2**			**1**						**3**		
CO3	**2**	**1**	**2**			**3**						**3**		
CO4	**2**	**1**	**2**			**1**						**3**		
CO5	**2**	**1**	**2**			**1**						**3**		
CO6	**2**	**1**	**2**			**1**						**3**		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

PART A: BASIC ELECTRICAL ENGINEERING

UNIT I: ELECTRICAL CIRCUITS AND MACHINES

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: AC Fundamentals: Equation of AC Voltage and current, waveform, time-period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor. (Simple Numerical problems).

Electrical Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer and (iv) Three Phase Induction Motor**,** Applications of electrical machines.

(12 Hours)

UNIT II: ELECTRICAL MEASURING INSTRUMENTS AND SAFETY MEASURES

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge.

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB) Personal safety measures: Electric Shock, Safety precautions to avoid shock, Earthing and its types.

(12 Hours)

PART B: BASIC ELECTRONICS ENGINEERING

UNIT III: SEMICONDUCTOR DEVICES AND ELECTRONIC CIRCUITS

Introduction - Evolution of electronics – Vacuum tubes to nanoelectronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier.

Rectifiers and power supplies: Block diagram description of a DC power supply, working of a half wave rectifier, full wave rectifier.

(12 Hours)

UNIT IV: DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT,

OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits– Minterm, Maxterm, SOP, Standard SOP, POS, Standard POS, 3-Variable K-Map, Half and Full Adders.

(12 Hours)

Textbooks:

1. R. L. Boylestad & Louis Nashlesky, "Electronic Devices & Circuit Theory," Pearson Education, 2nd Edition 2021.
2. D. C. Kulshreshtha "Basic Electrical Engineering" Tata McGraw Hill, 1st Edition, 2019
3. Ramana Pilla, N.V.Lalitha & G.Suresh, "Basic Electrical and Electronics Engineering", S Chand and Company Ltd., 1st Edition, 2024.

Reference Books:

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019, Fourth Edition
2. T. K. Nagsarkar & M. S. Sukhija, "Basic Electrical Engineering" Oxford University Press, 1st Edition, 2017
3. R. P. Jain, "Modern Digital Electronics" Tata Mc Graw Hill, 4th Edition, 2009.
4. Rajendra Prasad, "Fundamentals of Electrical Engineering," PHI publishers, 3rd Edition. 2014

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment Test (%)
Remember	20	20	30
Understand	50	50	50
Apply	30	30	20
Analyze	-	-	
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

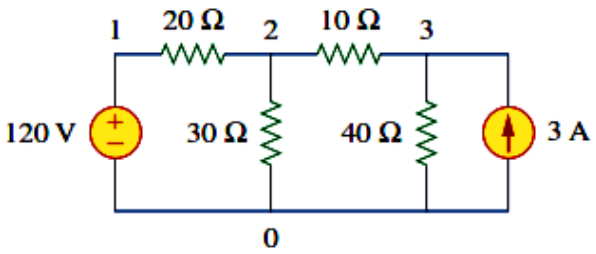
1. Define KVL and KCL
2. Define Units
3. Define amplifier
4. Define Rectifier

Understand

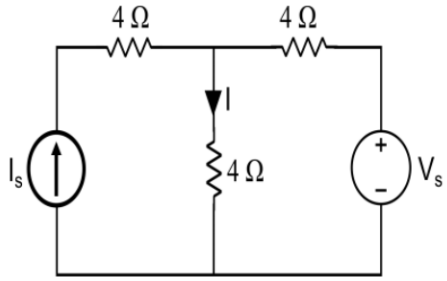
1. List out energy sources and explain anyone with a neat diagram
2. Illustrate the operation instruments with a neat diagram
3. List any three applications of Zener diode
4. Illustrate the CE amplifier circuit diagram.

Apply

1. Find currents in each branch using nodal analysis for the given circuit.



2. Find I by using the superposition theorem for the below circuit with V_S=20V, I_S= 4A.



3. Solve these conversions
   i) $(10101)_2$ to $(?)_{gray}$
   ii) $(23B)$ to $(?)_{10}$
   iii) $(45)_{10}$ to $(?)_8$

4. Minimize the given switching function using k-map f(A, B, C) = $\sum m(2,6,7)$

23BEX02 - BASIC CIVIL & MECHANICAL ENGINEERING

(Common to All branches of Engineering)

3 0 0 3

Course Outcomes:

1. Describe the basics of civil engineering streams, water resources and environmental engineering
2. Outline the concepts of surveying
3. Demonstrate the pavements and the concept of Airport, Harbour, Tunnel & Railway Engineering
4. Understand the different Engineering Materials, Manufacturing process and the role of mechanical Engineering in different sectors.
5. Understand the basic concepts of thermal engineering and working principles of different power plants
6. Describe the working of different mechanical power transmission systems and basic configurations and applications of robots

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-			2	2	2				2		
CO2	3	3	3			1	2	-				2		
CO3	3	-	-			1	2	-				2		
CO4	3	-	-			2	2	-				2		
CO5	3	-	-			2	2	-				2		
CO6	3	-	-			2	2	-				2		

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

UNIT I Basics of Civil Engineering

Basics of Civil Engineering: Role of Civil Engineers in Society- Various Disciplines of Civil Engineering- Structural Engineering- Geo-technical Engineering- Transportation Engineering- Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each discipline - Building Construction and Planning- Construction Materials-Cement - Aggregate - Bricks- Cement concrete- Steel. Introduction to prefabricated construction techniques.

Water Resources and Environmental Engineering: Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology–Rainwater Harvesting-Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

12 Hours

UNIT II Surveying and Transportation Engineering

Surveying: Objectives of Surveying - Horizontal Measurements- Angular Measurements- Introduction to Bearings, Levelling instruments used for levelling -Simple problems on levelling and bearings-Contour mapping.

Transportation Engineering: Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering **12 Hours**

UNIT III

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society-Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Engineering Material: Metals-Ferrous and Non-ferrous, Ceramics, Composites, Smart materials.

Manufacturing Processes: Principles of Casting, Forming, joining processes, Introduction to CNC machines, 3D printing, and Smart manufacturing. **11 Hours**

UNIT IV

Thermal Engineering: working principle of Boilers, Otto cycle, Diesel cycle, Refrigerator and air-conditioner, IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines, Components of Electric and Hybrid Vehicles.

Power plants: working principle of Steam, Diesel, Hydro, Nuclear power plants.

Mechanical Power Transmission: Belt Drives, Chain, Rope drives, Gear Drives and their applications.

Introduction to Robotics: configurations and applications of robots. **13 Hours**

Textbooks:

1. Basics of Civil and Mechanical Engineering, O. Srikanth and M. Sreenivasa Reddy, S. Chand and company limited, first edition, 2024.
2. Basic Civil Engineering, M. S. Palanisamy, Tata Mcgraw Hill publications (India) Pvt. Ltd. Fourth Edition.
3. Introduction to Civil Engineering, S. S. Bhavikatti, New Age International Publishers. 2022. First Edition.
4. Basic Civil Engineering, SatheeshGopi, Pearson Publications, 2009, First Edition.
5. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India) Pvt. Ltd.
6. A Text book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications, (India) Pvt. Ltd.
7. An introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, cengage learning India pvt. Ltd.

Reference Books:

1. Surveying, Vol- I and Vol-II, S.K. Duggal, Tata McGraw Hill Publishers 2019. Fifth Edition.
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, Khanna Publishers, Delhi. 2016.
3. Irrigation Engineering and Hydraulic Structures - Santosh Kumar Garg, Khanna Publishers, Delhi 2023. 38th Edition.
4. Highway Engineering, S. K. Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10th Edition.
5. Indian Standard DRINKING WATER — SPECIFICATION IS 10500-2012.
6. AppuuKuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I
7. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak M Pandey, Springer publications
8. Thermal Engineering by Mahesh M Rathore Tata Mcgraw Hill publications (India) Pvt. Ltd.
9. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, Tata Mcgraw Hill publications (India) Pvt. Ltd.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Assessments
Remember	9	9	9
Understand	63	63	63
Apply	28	28	28
Analyze			
Evaluate			
Create			
Total (%)	100	100	

Sample Question (s)

Remember

1. What is Portland cement? Write the Cement composition?
2. Define surveying. What are the principles of surveying?
3. Outline the key elements of railway engineering?
4. Write the purpose of tunnels?

Understand

1. Describe the key characteristics of contour mapping?
2. Discuss the fundamental differences between flexible pavements and rigid pavements.
3. What are the various types of transportation system? How the transportation is contributing the economy of the country India?
4. What is the importance of construction materials such as brick, cement, aggregates, concrete and steel in building construction?

Apply

1. The following readings were taken with a level in sequence as follows 1.625, 1.535, 2.365, 1.355, 1.465, 1.105, 1.925, 2.015, 2.350, 1.815, 1.985, 2.115 and 2.560. The elevation of B.M at 1st reading is 210m. Find the reduced levels at each and every station using rise and fall method.

2. In a closed traverse the following bearings were observed with a compass. Calculate the included angles with sketch?

Line	Fore bearing
AB	65° 00′
BC	125° 30′
CD	200° 00′
DE	265° 15′
EA	330° 00′

3. Convert the following whole circle bearings into reduced (quadrantal) bearings?
(i) 65° (ii) 143° 15′ (iii) 252° 30′ (iv) 320° 42′ (v) 181° 12′ (vi) 270° 42′

4. The following fore bearings were observed for lines, AB, BC, CD, DE, FE and FG respectively. Determine their back bearings.

i) FB of AB 310° 30′
ii) FB of BC 145° 15′
iii) FB of CD 210° 30′
iv) FB of DE 60° 45′
v) FB of EF 39° 50′
vi) FB of FG 289° 30′

23BEX03 - INTRODUCTION TO PROGRAMMING
(Common to all branches of Engineering)

3 0 0 3

Course Outcomes:

At the end of the Course, Student should be able to:

1. Illustrate the Algorithms for programming and problem solving.
2. Formulate sequential and iterative programming.
3. Implement Basic Dynamic Data structures
4. Develop Modular program aspects in solving complex problems.
5. Apply the concepts for optimal utilization of memory
6. Understand the techniques of storage and processing the data.

COs – POs Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3									2		
CO2	3	2	2									2		
CO3	3	2	2									2		
CO4	3	3	3									2		
CO5	3	2	2									2		
CO6	3	1	1									1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNITI

Introduction to Computer Problem Solving:

Programs and Algorithms, Computer Problem Solving Requirements, Phases of Problem Solving,
Problem Solving Strategies, Top-Down Approach, Algorithm Designing, Program Verification, Improving Efficiency, Algorithm Analysis and Notations.
Introduction, Structure of a C Program, Comments, Keywords, Identifiers, Data Types, Variables, Constants, Input/output Statements. Operators, Type Conversion Relational Expressions

UNITII

Introduction to C Programming:

Control Flow, Conditional Branching Statements: if, if-else, if-else—if, switch. Basic Loop Structures: while, do-while loops, for loop, nested loops, The Break and Continue Statements, goto statement.

Arrays:

Introduction, Operations on Arrays, Arrays as Function Arguments, Two Dimensional Arrays, Multidimensional Arrays.
Strings: String Fundamentals, String Processing with and without Library Functions, Pointers and Strings.

UNIT- III

Functions: Introduction Function: Declaration, Function Definition, Function Call, Categories of Functions, Passing Parameters to Functions, Scope of Variables, Variable Storage Classes, Recursion.
Pointers: Concept of a Pointer, Declaring and Initializing Pointer Variables, Pointer Expressions and Address Arithmetic, Null Pointers, Generic Pointers, Pointers as Function Arguments, Pointers and Arrays, Pointer to Pointer, Dynamic Memory Allocation, Dangling Pointer, Command Line Arguments.

UNIT-IV

Structures, Unions, Bit Fields: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type —Enum variables, Using Type def keyword, Bit Fields. Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

Textbook(s)

1. A Structured Programming Approach UsingC, Forouzan, Gilberg, 3rd Edition, Cengage.
2. How to solve it by Computer. G. Dromey, 12thEdition, Pearson Education.
3. Programming In CA-Practia1Approach.AjayMittal, 1st Edition Pearson

References:

1. Byron Gottfried, Schaum's Outline of Programming with C, 4thEdition, 2020, McGraw-Hill.
2. ComputerProgramming.ReemaThareja, 3rd Edition, 2023, Oxford University Press
3. The C Programming Language, Dennis Richie And Brian Kernighan, 2nd Edition, Pearson Education.
4. Programming InC, Ashok Kamthane,2nd Edition,PearsonPublication.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Assessments
Remember	20	10	
Understand	50	40	
Apply	30	30	100
Analyze	--	20	
Evaluate			
Create			
Total (%)			

Sample Question (s)

Remember

1. Define an algorithm.
2. List out the types of operators.
3. Define a function.
4. List any 5 file handling functions.

Understand

1. What is a 2D array? Explain the process of creating, initializing and accessing the elements of a 2D array.
2. Explain the 4 categories of functions.
3. Explain the difference between structure and union.
4. Explain the modes of opening a file.

Apply

1. Write a program to generate the Fibonacci sequence using recursion.
2. Write a program to perform matrix multiplication.
3. Write a program to copy the contents of

23BEX04 - ENGINEERING GRAPHICS
(Common to All branches of Engineering)

2 0 2 3

Course Outcomes

1. Understand the principles of engineering drawing, including engineering curves, scales.
2. Draw and interpret orthographic projections of points, lines, planes in front, top and side views.
3. Construct Ortho-graphic projections of planes inclined to both reference planes and Projections of Solids in simple positions.
4. Understand and apply concepts of projections of solids inclined to a reference plane and sectional views of solids in simple positions using CAD software.
5. Gain a clear understanding of the principles behind development of surfaces and to understand how to unfold basic geometric shapes into flat patterns using CAD software.
6. Develop the ability to draw isometric views and orthographic views and convert isometric views to orthographic views and vice versa using CAD software.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				-					3		3		
CO2	3				-					3		3		
CO3	3				-					3		3		
CO4	3				3					3		3		
CO5	3				3					3		3		
CO6	3				3					3		3		

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

UNIT I

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.

Curves: construction of ellipse, parabola and hyperbola by general and special methods – Arcs of circle method, concentric circles method, Oblong method, Rectangle method, Normal and tangent to Curves. **Scales:** Introduction to scales, Plain scales, Diagonal scales. **9 Hours**

UNIT II

Projections of Points &Straight Lines: Projections of points, Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes.

Projections of Planes: regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes. **Projections of Solids:** Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane.

(Conventional drawing up to this) **9 Hours**

(Using CAD)

UNIT III

Projections of Solids

Introduction to AUTOCAD, Projection of Solids with axis inclined to one reference plane and parallel to other, Projection of Solids with axis parallel to both the reference planes.

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids in simple position only.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone. **10 Hours**

UNIT IV

Conversion of Views: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views. **10 Hours**

Total: 48 Hours

Textbook:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House, 2016.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2013.

2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc,2009.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, Tata McGraw Hill, 2017.

23HSX01 COMMUNICATIVE ENGLISH
(Common to all branches of Engineering)

2 0 0 2

Course Outcomes

1. Understand the context, topic, and specific information from social or transactional dialogues
2. Speak clearly using discourse markers on a specific topic in formal as well as informal discussions
3. Comprehend and appreciate literary texts by reading
4. Write summaries, coherent paragraphs, essays, letters/e-mails and resume
5. Apply grammatical structures to formulate sentence and use them appropriately
6. Improve communicative competence with enhanced vocabulary in formal and informal contexts

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1								1	3	1	2		
CO2	1								1	3	1	2		
CO3	1								1	3	1	1		
CO4	1								1	3	1	2		
CO5	1								1	3	1	1		
CO6	1								1	3	1	1		

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Lesson : The power of plate of Rice- Ifeoma Okoye

Listening: Identifying the topic, the context and specific pieces of information by listening to Short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words

Unit 2

Lesson: Night of the Scorpion by Nissim Ezekiel, Steve Jobs

Listening: Answering a series of questions about main ideas and supporting ideas after listening to audio texts. Listening for global comprehension and summarizing what is listened

Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks and reporting what is discussed

Reading: Identifying sequence of ideas; verbal techniques that connect ideas in a paragraph, reading a text by making inferences-using context clues for comprehension.

Writing: Structure of a paragraph - Paragraph writing (specific topics), summarizing

Grammar: Cohesive devices -linkers, use of articles and zero article, prepositions.

Vocabulary: Homonyms, Homophones, Homographs.

Unit 3

Lesson: The Toys of Peace by Saki

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.

Writing: Note-making, paraphrasing Letter Writing: Official Letters, Resumes

Grammar: Verbs – tenses, subject-verb agreement Reporting verbs, Direct & Indirect speech, Active & Passive Voice

Vocabulary: Words often confused, Compound words, Collocations

Unit 4

Lesson: The Power of Interpersonal Communication

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal oral presentations on topics from academic on texts

Reading: Reading comprehension.

Writing: Writings structured essays on specific topics.

Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject-verb agreement)

Vocabulary: Jargons, Technical vocabulary

Textbook (s)

1. *Pathfinder*: Communicative English for Undergraduate Students, 1st Edition, Orient Black Swan, 2023.
2. *Empowering English* by Cengage Publications, 2023

Reference Books:

1. Dubey, Sham Ji& Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20%	20%	
Understand	29%	29%	
Apply	51%	51%	50%
Analyse			50%
Evaluate			
Create			
Total (%)			

Sample Question (s)

Remember

1. Explain the role of body language in inferential listening.
2. What announcement by the national peace council does Eleanor show her brother?
3. Reflect on the role of intrapersonal communication in personal growth, how can engaging in self-reflection and self-talk contribute in enhancing one's character and decision-making abilities?
4. Explain the role of body language in inferential listening.

Understand

1. What do you mean by listening for main ideas and supporting ideas?
2. What are the qualities of a good listener?
3. You recently have purchased a smartphone that has unexpectedly poor battery life. Compose a letter to the customer service department of the store where you bought it, explaining the issue and politely requesting a replacement or repair.
4. Explain briefly some situations that require inferential listening.

Apply

1. Write a short talk on 'memorable incident in your life'
2. Develop a conversation between two friends on positive impact that regular physical exercise can have on both physical and mental well-being.
3. Summarize the central idea of the poem *Night of the Scorpion by Nissim Ezekel.*
4. Imagine you are a customer support representative dealing with a dissatisfied customer. Create a role-playing scenario to address the customer's concerns and resolve the issue to their satisfaction.

23PYX02 - ENGINEERING PHYSICS LAB
(Common to all branches of Engineering)

0 0 2 1

Course Outcomes

1. Infer the knowledge from the scientific methods and learn the process of measuring different physical parameters
2. Develop the laboratory skills in handling of electrical and Optical instruments
3. Demonstrate the interference and diffraction phenomena of light
4. Inspect and experience physical principles of Magnetic fields and optical fiber communications
5. Apply the principles of physics and measure the solid state properties of materials
6. Design and analyze experiment based on physics concepts

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				3		2			2		2	1		
CO2				3		2			2		2	1		
CO3				3		2			2		2	1		
CO4				3		2			2		2	1		
CO5				3		2			2		2	1		
CO6				3		2			2		2	1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments:

1. Study of variation of magnetic field along the axis of current-carrying circular coil-Stewart and Gee's Method.
2. Determination of wavelengths of spectral line of mercury spectrum using diffraction grating.
3. Determination of radius of curvature of convex lens by forming Newton's rings.
4. Study of series and parallel Resonance in LCR circuit.
5. Measurement of thickness of a thin paper using wedge method.
6. Calculation of Numerical Aperture (NA) and bending losses of a given fiber.
7. Determination of frequency of an electrically vibrating tuning fork in Transverse and longitudinal modes - Melde's Experiment.
8. Determination of wavelength of Laser by diffraction grating.
9. Determination of Hall Coefficient and charge carrier density of semi-conductor.
10. Determination of Band gap of a semiconductor.
11. Determination of Rigidity modulus of a given wire using torsional pendulum.
12. Determination of size of particle using diffraction pattern.
13. Verification of Malu's law.
14. Determination of temperature coefficients of a thermistor.
15. Determination of dispersive power of the material of a prism.
16. Determination of Time constant of an R-C circuit.

List of Augmented Experiments[1]

1. To study the magnetization (M) of a ferromagnetic material in the presence of a magnetic field B and to plot the hysteresis curve (M vs. B)
2. Study the Thermoemf of the thermo couple
3. LCR Series and Parallel–Design of circuit for various resonance frequencies
4. Determination of characteristics of Laser beam
5. Determination of Horizontal component of earth's magnetic field
6. Study of double refraction in calcite crystals

[1] Students shall opt any one of the Augmented Experiments in addition to the regular experiments

7. Dispersive power of various liquids using spectrometer 8. Photo cell–Characteristics and determination of Planks constant
9. Michelson's interferometer.

References:

1. Physics Lab manual–Department of Physics, BS & H, GMRIT, Rajam, 2019
2. S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S Chand Publishers, 2017
3. Y. Aparna and K. Venkateswararao, Engineering Physics–I and II, VGS Techno series, 2010 4. S. Panigrahi and B. Mallick, Engineering Practical Physics, Cengage leaning, Delhi, 2015
4. http://www.amrita.vlab.co.in Virtual Labs, Amrita University.
5. http:/www./iitk.vlab.co.in

23CYX03 - CHEMISTRY LAB – EEE, ECE, CSE, IT, AI&ML, AI&DS

0 0 2 1

Course Outcomes:

At the end of course student will be able to

CO1: Determine the concentration of acids by Conductometry.
CO2: Prepare the Bakelite polymer and ZnO nanomaterial
CO3: Estimate the strength of an acid present in secondary battery by pH metry
CO4: Identify the organic compounds by IR Spectroscopy.
CO5: Verify the Beer- Lamberts law and measure the wavelength
CO6: Estimate concentration of ferrous iron by potentiometry and dichrometry

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1	3		1			1		
CO2	3					1	3		1			1		
CO3	3					1	3		1			1		
CO4	3					1	2		1			1		
CO5	3					1	3		1			1		
CO6	3					1	3		1			1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

LIST OF EXERCISES:

1. Introduction to qualitative analysis- Demonstration
2. Measurement of 10Dq by spectrophotometric method
3. Conductometric titration of strong acid vs. strong base
4. Conductometric titration of weak acid vs. strong base
5. Determination of cell constant and conductance of solutions
6. Potentiometry - determination of redox potentials and emfs
7. Determination of Strength of an acid in Pb-Acid battery
8. Preparation of a Bakelite
9. Verify Lambert-Beer's law
10. Wavelength measurement of sample through UV-Visible Spectroscopy
11. Identification of simple organic compounds by IR
12. Preparation of nanomaterials by precipitation method
13. Estimation of Ferrous Iron by Dichrometry
14. Determination of acid number of lubricating oil
15. Determination of Hardness of a groundwater sample.
16. Determination of Viscosity of lubricating oil by Redwood Viscometer 1

List of Augmented Experiments1

1. Assessment of synthesis of carbon fibers by polymerization
2. Synthesis of nanomaterials by other nanomethodlogy
3. Identification of simple organic compounds by IR
4. Making a battery of required potential
5. Calculation of Ferrous Iron by Dichrometry.
6. Find the acid number of various industrial oils or edible oils

Reference Books

1. Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C. Denney, J.D. Barnes and B. Sivasankar

23CYX04 - ENGINEERING CHEMISTRY LAB – CIVIL, MECH

0 0 2 1

Course outcomes:

At the end of course student will be able to
CO1: Asses the percentage moisture of a solid fuel
CO2: Prepare the Bakelite polymer and ZnO nanomaterial
CO3: Determine acid number and viscosity of lubricating oil
CO4: Estimate the Iron and Calcium in cement.
CO5: Estimate the hardness and dissolved oxygen in water.
CO6: Determine the Strength of an acid in lead acid Battery

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1	3		1			1		
CO2	3					1	3		1			1		
CO3	3					1	3		1			1		
CO4	3					1	2		1			1		
CO5	3					1	3		1			1		
CO6	3					1	3		1			1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

LIST OF EXERCISES:

1. Introduction to Quantitative Analysis - Demonstration
2. Determination of Hardness of a groundwater sample.
3. Estimation of Dissolved Oxygen by Winkler's method
4. Determination of Fluoride in water sample
5. Determination of nitrite in water sample by spectrometric method
6. Determination of percentage of Iron in Cement sample by colorimetry
7. Estimation of Calcium in Portland cement
8. Determination of Strength of an acid in Pb-Acid battery 9. Preparation of a polymer (Bakelite)
10. Preparation of nanomaterials by precipitation method
11. Adsorption of acetic acid by charcoal
12. Determination of percentage Moisture content in a coal sample
13. Determination of acid number of lubricating oil
14. Determination of Viscosity of lubricating oil by Redwood Viscometer 1
15. Determination of Viscosity of lubricating oil by Redwood Viscometer 2
16. Determination of Calorific value of gases by Junker's gas Calorimeter

List of Augmented Experiments1

1. Assessment of ground water quality of your village/Mandal (by taking min. 6 locations and determining min. 4 parameters – Fluoride, Chloride, Hardness, TDS etc.)
2. Preparation of a desired quality of Viscosity Index lubricating oil
3. Proximate analysis of coal – Ultimate analysis of coal
4. Making a battery of required potential
5. Energy scenario in India- Various sources, % consumption, solutions to meet future demand etc.
6. Find the viscosity of various edible and non-edible lubricating oils

Reference Books

1. Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C. Denney, J.D. Barnes and B. Sivasankar
2. Waste Water Engineering Treatment and Reuse, 4th Edition, Metcalf and Eddy, Inc
3. Engineering chemistry laboratory manual & record By Srinivasulu D. Parshva publications

23BEX05 - ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP
(Common to All branches of Engineering)

0 0 3 1.5

Course Outcomes

1. Apply fundamental electrical principles to resolve complex circuit problems.
2. Develop proficiency in conducting electrical measurements and studying machine characteristics for practical applications.
3. Demonstrate skills in measuring power parameters and calculate energy consumption for residential applications.
4. Analyze the characteristics of semiconductor devices
5. Find the frequency response of amplifiers using BJT
6. Verify the truth tables of logic gates and basic flip flops

CO–PO Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				3	2	1			1			1		
CO2				3	2	1			1			1		
CO3				3	2	1			1			1		
CO4				3	2	1			1			1		
CO5				3	2	1			1			1		
CO6				3	2	1			1			1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Activities:

1. Familiarization of commonly used Electrical & Electronic Workshop Tools: Bread board, Solder, cables, relays, switches, connectors, fuses, Cutter, plier, screwdriver set, wire stripper, flux, knife/blade, soldering iron, de-soldering pump etc.
   - Provide some exercises so that hardware tools and instruments are learned to be used by the students.
2. Familiarization of Measuring Instruments like Voltmeters, Ammeters, multimeter, LCR-Q meter, Power Supplies, CRO, DSO, Function Generator, Frequency counter.
   - Provide some exercises so that measuring instruments are learned to be used by the students.
3. Components:
   - Familiarization/Identification of components (Resistors, Capacitors, Inductors, Diodes, transistors, IC's etc.) – Functionality, type, size, colour coding package, symbol, cost etc.
   - Testing of components like Resistor, Capacitor, Diode, Transistor, ICs etc. - Compare values of components like resistors, inductors, capacitors etc with the measured values by using instruments

PART A: ELECTRICAL ENGINEERING LAB
List of experiments:

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheat stone bridge
4. Magnetization Characteristics of DC shunt Generator
5. Measurement of Power and Power factor using Single-phase wattmeter
6. Measurement of Earth Resistance using Megger
7. Calculation of Electrical Energy for Domestic Premises **Note:** Minimum Six Experiments to be performed.

PART B: ELECTRONICS ENGINEERING LAB List of
Experiments:

1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias.
2. Plot V – I characteristics of Zener Diode and its application as voltage Regulator.
3. Implementation of half wave and full wave rectifiers Plot Input & Output characteristics of BJT in CE and CB configurations
4. Frequency response of CE amplifier.

5. Simulation of RC coupled amplifier with the design supplied
6. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs.
7. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs. Tools / Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

List of Augmented Experiments.

1. Connections of Tube Light wiring
2. Connections of Godown Wiring
3. Connections of stair case wiring
4. Generate fixed positive 5V using IC7405
5. Generate fixed Negative 5V using IC7905
6. Generate sinusoidal wave form using function generator

Reference Books:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, PearsonEducation, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education,2009.
4. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
5. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti,Dhanpat Rai & Co, 2013
6. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using both Hardware and Software.

23BEX06 - ENGINEERING WORKSHOP
(Common to all branches of Engineering)

0 0 3 1.5

Course Outcomes:

At the end of this course a student will be able to

1. Demonstrate the simple wooden components like Cross Lap joint, T-Lap joint, Dovetail Joint.
2. Develop the simple house hold items like Taper Tray, Square box, Open Scoop using sheet metal.
3. Build the V- Fit, Square fit, Dovetail fit using mild steel.
4. Understand simple house wiring circuits like Parallel/Series connection of three bulbs, Stair Case Wiring, Godown Wiring.
5. Create the Green Sand Mould for given the patterns like rectangular shape, circular shape.
6. Construct the metal joint using Arc Welding like: Lap joint, Butt joint.

COs – POs Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3								3			2		
CO2	3								3			2		
CO3	3								3			2		
CO4	3								3			2		
CO5	3								3			2		
CO6	3								3			2		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Demonstration: Safety practices and precautions to be observed in workshop.
Wood Working: Familiarity with different types of woods and tools used in wood working and make following joints: a) Cross Lap joint, b) T-Lap joint, c) Dovetail Joint.
Sheet Metal Working: Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets: a) Taper Tray, b) Square box, c) Open Scoop.
Fitting: Familiarity with different types of tools used in fitting and do the following fitting exercises: a) V- Fit, b) Dovetail fit, c) Half Round Fit.
Electrical Wiring: Familiarity with different types of basic electrical circuits and make the following connections: a) Parallel/Series connection of three bulbs, b) Stair Case Wiring, c) Godown Wiring **Foundry:** Demonstration of Moulding tools and processes, Preparation of Green Sand Moulds for given Patterns: a) rectangular shape mould, b) circular shape mould
Welding Shop: Demonstration and practice on Arc Welding. Preparation of a) Lap joint and b) Butt joint.

LIST OF EXPERIMENTS:

Wood Working:

1. Cross Lap joint,
2. T-Lap joint,
3. Dovetail Joint **Sheet Metal Working**:
4. Taper Tray,
5. Square box,
6. Open Scoop

Fitting:

1. V- Fit,
2. Square fit,
3. Dovetail fit, **Electrical Wiring**:
4. Parallel/Series connection of three bulbs,
5. Stair Case Wiring,
6. Godown Wiring

Foundry Trade:

1. Mould cavity for rectangular shape
2. Mould cavity for a straight pipe **Welding Shop**:
3. Lap joint

4. Butt joint.

 # Any two jobs from each trade must be performed by the student.

AUGMENTED EXPERIMENT / MINI PROJECT: An innovative and creative useful house hold product/model should be prepared by the group of 6-10 students using the knowledge gathered from the all shops in workshop.

TEXTBOOKS:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published,2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.

REFERENCE BOOKS:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
3. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan, 2021-22.

23BEX07 - COMPUTER PROGRAMMING LAB
(Common to all branches of Engineering)

0 0 3 1.5

Course Outcomes:

At the end of the Course, Student will be able to:

1. Read, understand, and trace the execution of programs.
2. Select the proper control structure for solving the problem.
3. Construct programs using homogenous data types.
4. Develop modular programming using functions
5. Formulate programs for optimal utilization of memory.
6. Develop programs using files.

COs – POs Mapping:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	2	3								2		
CO2		2	3	3								2		
CO3		2	3	3								2		
CO4		2	3	3								2		
CO5		2	3	3								2		
CO6		2	3	3								2		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments:

UNIT-I

WEEK 1:

Objective: Getting familiar with the programming environment on the computer and writing the first program.

Suggested Experiments/Activities:

Tutorial 1: Problem-solving using Computers.

Lab1: Familiarization with the programming environment

i) Basic Linux environment and its editors like Vi, Vim &Emacs etc. ii)
Exposure to Turbo C, gcc iii) Writing simple programs using printf(), scanf()

WEEK 2:

Objective: Getting familiar with how to formally describe a solution to a problem in a seriesof finite steps using textual and graphic notation.

Suggested Experiments /Activities:

Tutorial 2: Problem-solving using Algorithms and Flow charts.

Lab 1: Converting algorithms/flow charts into C Source code.

Developing the algorithms/flowcharts for the following sample programs i) Sum and
average of 3 numbers ii) Conversion of Fahrenheit to Celsius and vice versa iii)
Simple interest calculation

WEEK 3:

Objective: Learn how to define variables with the desired data-type, initialize them with appropriate values and how arithmetic operators can be used with variables and constants.

Tutorial 3: Variable types and type conversions:

Lab 3: Simple computational problems using arithmetic expressions. i) Finding
the square root of a given number ii) Finding compound interest
iii) Area of a triangle using Heron's formulae iv)
Distance traveled by an object

UNIT-II

WEEK4

Objective: Explore the full scope of expressions, type-compatibility of variables & constants and operators used in the expression, and how operator precedence works.

Suggested Experiments/Activities:

Tutorial4: Operators and the precedence and as associativity:

Lab4: Simple computational problems using the operator's precedence and associativity i) Evaluate the following expressions.

a. A+B*C+(D*E) + F*G
b. A/B*C-B+A*D/3
c. c. A+++B---A
d. d. J= (i++) + (++i)

ii) Find the maximum of three numbers using the conditional operator iii) Take marks of 5 subjects in integers, and find the total, average in float

WEEK 5:

Objective: Explore the full scope of different variants of ―if construct‖, namely if-else, null-- else, if-else if*-else, switch, and nested-if, including in what scenario each can be used and how to use them. Explore all relational and logical operatorswhile writing conditionals for ―if construct‖.

Suggested Experiments/Activities:

Tutorial 5: Branching and logical expressions: Lab 5: Problems involving if-then-else structures.

i) Write a C program to find the max and min of four numbers using if-else.
ii) Write a C program to generate electricity bill. iii) Find the roots of the quadratic equation. iv) Write a C program to simulate a calculator using a switch case.

v) Write a C program to find whether the given year is a leap year.

WEEK 6:

Objective: Explore the full scope of iterative constructs, namely while loop, do-while loop, and for loop in addition to structured jump constructs like break and continue, including when eachof these statements is more appropriate. Suggested Experiments/Activities:

Tutorial 6: Loops, while and for loops

Lab 6: Iterative problems, e.g., the sum of series

i) Find the factorial of a given number using any loop. ii) Find whether the given number is a prime or not. iii) Compute sine and cos series iv) Checking whether a number is palindrome

v) Construct a pyramid of numbers.

UNIT-III

WEEK7:

Objective: Explore the full scope of the Arrays construct, namely defining and initializing 1-D and 2-D and, More generically, n-D arrays and referencing individual array elements from the defined array. Using integer 1-D arrays,explore search solution linear search.

Suggested Experiments/Activities:

Tutorial 7: 1 D Arrays: searching. Lab 7:1D Array manipulation, linear search

i) Find the min and max of a 1-D integer array.
ii) Perform linear search on the 1D array.
iii) The reverse of a 1D integer array iv) Find 2's complement of the given binary number. v) Eliminate duplicate elements in an array.

WEEK 8:

Objective: Explore the difference between other arrays and character arrays that can be used as Strings by using null characters and get comfortable with strings by doing experiments that will reverse a string and concatenate two strings. Explore sorting solution bubble sort using integer arrays.

Suggested Experiments/Activities:

Tutorial 8: 2 D arrays, sorting and Strings.

Lab 8: Matrix problems, String operations, Bubble sort i) Addition of two matrices ii) Multiplication two matrices iii) Sort array elements using bubble sort iv) Concatenate two strings without built-in functions

v) Reverse a string using built-in and without built-in string functions

UNIT-IV

WEEK9:

Objective: Explore pointers to manage a dynamic array of integers, including memory allocation value initialization,resizing, changing, and reordering the contents of an array, and memory deallocation using malloc (), calloc (),realloc () and free () functions. Gain experience processing command-line arguments received by C Suggested Experiments/Activities:

Tutorial 9: Pointers, structures, and dynamic memory allocation Lab 9:
Pointers and structures, memory dereference.
i) Write a C program to find the sum of a 1D array using malloc() ii) Write a C program to find the total average of n students using structures iii) Enter n students data using calloc() and display failed students list iv) Read student name and marks from the command line and display the student details along with the total.
v) Write a C program to implement realloc()

WEEK 10:

Objective: Experiment with C Structures, Unions, bit fields self-referential structures(Singlylinked lists), and nested structures Suggested Experiments/Activities:
Tutorial 10: Bitfields, Self-Referential Structures, Linked lists
Lab10: Bitfields
Read and print a date using dd/mm/yyyy format using bit-fields and differentiate the same without using bitfields

i) Create and display a singly linked list using self-referential structure.

ii) Demonstrate the differences between structures and unions using a C program. iii) Write a C program to shift/rotate using bitfields. iv) Write a C program to copy one structure variable to another structure of the same type.

UNIT-V

WEEK 11:

Objective: Explore the Functions, sub-routines, scope and extent of variables, doing some experiments by Parameter passing using call by value. Basic methods of numerical integration Suggested Experiments/Activities:
Tutorial 11: Functions, call by value, scope and extent,
Lab 11: Simple functions using call by value, solving differential equations using Eulers theorem.

i) Write a C function to calculate NCR value.
ii) Write a C function to find the length of a string.
iii) Write a C function to transpose of a matrix. iv) Write a C function to demonstrate numerical integration of differential equations using Euler's method

WEEK 12:

Objective: Explore how recursive solutions can be programmed by writing recursive functions that can be invoked from the main by programming at-least five distinct problems that have naturally recursive solutions.
Suggested Experiments/Activities:
Tutorial 12: Recursion, the structure of recursive calls
Lab 12: Recursive functions

i) Write a recursive function to generate Fibonacci series. ii) Write a recursive function to find the lcm of two numbers. iii) Write a recursive function to find the factorial of a number. iv) Write a C Program to implement Ackermann function using recursion. v) Write a recursive function to find the sum of series.

WEEK 13:

Objective: Explore the basic difference between normal and pointer variables, Arithmetic operations using pointers and passing variables to functions using pointers Suggested Experiments/Activities:
Tutorial 13: Call by reference, dangling pointers
Lab 13: Simple functions using Call by reference, Dangling pointers. i) Write a C program to swap two numbers using call by reference.

ii) Demonstrate Dangling pointer problem using a C program. iii) Write a C program to copy one string into another using pointer. iv) Write a C program to find no of lowercase, uppercase, digits and other characters using pointers.

WEEK14:

Objective: To understand data files and file handling with various file I/O functions.Explore the differences Between text and binary files.
Suggested Experiments/Activities:
Tutorial 14: File handling
Lab 14: File operations

i) Write a C program to write and read text into a file. ii) Write a C program to write and read text into a binary file using fread() and fwrite() iii) Copy the contents of one file to another file. iv) Write a C program to merge two files into the third file using command-line arguments. v) Find no. of lines, words and characters in a file

List of Augmented Experiments:

1. Employee'sManagement System
2. Librarymanagement system
3. Automationofdepartment store
4. PersonalDairy Management
5. TelecomBilling Management
6. BankManagement System
7. Contacts Management

Text books:

1. Ajay Mittal, Programming in C: A practical approach, 1 st Edition, Pearson.
2. Byron Gottfried, Schaum' s Outline of Programming with C, 4th Edition, 2020, McGraw Hill.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice- Hall of India. C Programming,
2. A Problem-Solving Approach, Forouzan, Gilberg, Prasad,3rdEdn, CENGAGE.

23BEX08 - IT WORKSHOP
(Common to all branches of Engineering)

0 0 2 1

Course Outcomes:

At the end of the Course, Student will be able to:

1. Demonstrate the process of Assembling and disassembling the PC.
2. Illustrate the steps involved in installations of various operating systems.
3. Understand the process of Configuring IP address and perform virus free downloads.
4. Create projects using Latex/ Word and organize data and spreadsheets.
5. Design basic and interactive Power Point Presentations.
6. Improve Conversational abilities using AI-Tools.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2					3			3		
CO2	2	3	2	3					3			2		
CO3	3	2	2	2					3			2		
CO4	2	3	2	2					3			2		
CO5	3	3	3	2					3			2		
CO6	2	2	2	2					3			2		

3 - Strongly Linked | 2 – Moderately Linked | 1 – Weakly Linked

PC Hardware

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the block diagram of the CPU along with the configuration of each peripheral and submit to your instructor. **Task 2:** Every student should disassemble and assemble the PC back to working condition. Lab instructors should verify the work and follow it up with a Viva. Also, students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.

Task 3: Every student should individually install MS windows on the personal computer. Lab instructor should verify the installation and follow it up with a Viva.

Task 4: Every student should install Linux on the computer. This computer should have windows installed. The system should be configured as dual boot with both Windows and Linux. Lab instructors should verify the installation and follow it up with a Viva

Internet & World Wide Web

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally, students should demonstrate, to the instructor, how to access the websites and email. If there are no internet connectivity preparations need to be made by the instructors to simulate the WWW on the LAN. **Task 2:** Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop-up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

Task 3: Search Engines & Netiquette: Students should know what search engines are and how to use the search engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student.

Task 4: Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They need to customize their browsers to block pop ups, block active x downloads to avoid viruses and/or worms.

LaTeX and WORD

Task 1 – Word Orientation: The mentor needs to give an overview of LaTeX and Microsoft (MS) office or equivalent (FOSS) tool word: Importance of LaTeX and MS office or equivalent (FOSS) tool Word as word Processors, Details of the four tasks and features that would be covered in each, Using LaTeXand word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter in word.

Task 2: Using LaTeX and Word to create a project certificate. Features to be covered: - Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colours, Inserting Header and Footer, Using Date and Time option in both LaTeX and Word.

Task 3: Creating project abstract Features to be covered: -Formatting Styles, inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.
Task 4: Creating a Newsletter: Features to be covered: - Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word.

EXCEL
Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS) tool Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered in each. Using Excel – Accessing, overview of toolbars, saving excel files, Using help and resources. **Task 1:** Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text
Task 2: Calculating GPA -Features to be covered:- Cell Referencing, Formulae in excel – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function.

LOOKUP/VLOOKUP
Task 3: Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting

POWERPOINT
Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.
Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts.
Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides.

AI TOOLS – ChatGPT
Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model responds. Try asking questions, starting conversations, or even providing incomplete sentences to see how the model completes them.
Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: What is the capital of France?"
Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to brainstorm creative ideas
Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."
Task 3: Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output to see how accurate and fluent the translations are.
Ex:Prompt: "Translate the following English sentence to French: 'Hello, how are you doing today?'"

Reference Books:

1. Comdex Information Technology course tool kit Vikas Gupta, WILEY Dream tech
2. The Complete Computer upgrade and repair book, 3rd edition Cheryl A Schmidt, WILEY Dream tech
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education. 4. PC Hardware - A Handbook – Kate J. Chase PHI (Microsoft)
5. LaTeX Companion – Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide Third Edition by David Anfins on and Ken Quamme. – CISCO Press, Pearson Education.
7. IT Essentials PC Hardware and Software Labs and Study Guide Third Edition by PatrickRegan– CISCO Press, Pearson Education.

23HSX02 - COMMUNICATIVE ENGLISH LAB
(Common to all branches of Engineering)

0 0 2 1

Course Outcomes

1. Acquire knowledge of the English sound system and get practice to gain accuracy in pronunciation
2. Apply the patterns of accent and intonation for better listening and speaking comprehension
3. Write emails, resume and statement effectively for the purpose for professional communication
4. Evaluate and exhibit professionalism in participating in debates and group discussions
5. Demonstrate the necessary verbal and non-verbal communication in technical presentations
6. Perform different roles and practice interpersonal communication in formal situations

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1								1	3	1	2		
CO2	1								1	3	1	1		
CO3	1								1	3	1	2		
CO4	1								1	3	1	1		
CO5	1								1	3	1	2		
CO6	1								1	3	1	1		

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

List of Experiments

1. Letters and Sounds of English
2. Role play/ Conversation Practice-1
3. Jam
4. E-Mail Writing
5. Prounciation Rules
6. Role play/ Conversation Practice-II
7. Accent rules and Intonation
8. Presentation Skills
9. Resume Writing
10. Debating
11. Group Discussion
12. Interviews
13. Poster Presentation
14. Statement of Purpose
15. Role play/ Conversation Practice-3 16. Role play/ Conversation Practice-4

Augmented Experiment

List of Augmented Experiments[2]

1. Common Errors in English
2. Listening Skills
3. Writing Skills
4. Reading Skills
5. Public Speaking
6. Interview Skills
7. Business Communication

8. Functional English
9. Preparation for GRE/TOEFL
10. Preparation for IELTS/CAT/GMAT

[1]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

Reading Material (s)

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford Press.2018.
2. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India, 2016
3. Hewing's, Martin. Cambridge Academic English (B2). CUP, 2012.
4. J. Sethi& P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, 2013
5. K. Nirupa Rani, Jayashree Mohan Raj, B. Indira, (Ed) Speak Well (C.D) Orient Black Swan Pvt Ltd, Hyderabad, 2012

Web Resources:

Spoken English:

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com/
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. https://www.youtube.com/c/ArnelsEverydayEnglish/featured
8. https://www.youtube.com/c/engvidAdam/featured
9. https://www.youtube.com/c/EnglishClass101/featured
10. https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw

Voice & Accent:

1. https://www.youtube.com/user/letstalkaccent/videos
2. https://www.youtube.com/c/EngLanguageClub/featured
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

23HSX11 - HEALTH AND WELLNESS, YOGA AND SPORTS
(Common to All branches of Engineering)

0 0 1 0.5

Course Objectives:
The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits required for the development of the personality.

Course Outcomes: After completion of the course the student will be able to
CO1: Understand the importance of yoga and sports for Physical fitness and sound health.
CO2: Demonstrate an understanding of health-related fitness components.
CO3: Compare and contrast various activities that help enhance their health.
CO4: Assess current personal fitness levels.**CO5:** Develop Positive Personality

UNIT I
Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.
Activities:
i) Organizing health awareness programmes in community ii) Preparation of health profile
iii) Preparation of chart for balance diet for all age groups

UNIT II
Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.
Activities:
Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III
Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.
Activities:
i) Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.
Practicing general and specific warm up, aerobics ii) Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping andrunning.

Reference Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning,2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc.2014

General Guidelines:
1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many as Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Evaluation Guidelines:
1. Evaluated for a total of 100 marks.
2. A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalling to 90 marks.
3. A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

23HSX12 -NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE
(Common to All branches of Engineering)

0 0 1 0.5

Course Objectives:
The objective of introducing this course is to impart discipline, character, fraternity, teamwork, social consciousness among the students and engaging them in selfless service.

Course Outcomes: After completion of the course the students will be able to **CO1:** Understand the importance of discipline, character and service motto.
CO2: Solve some societal issues by applying acquired knowledge, facts, and techniques.
CO3: Explore human relationships by analyzing social problems.
CO4: Determine to extend their help for the fellow beings and downtrodden people. **CO5:** Develop leadership skills and civic responsibilities.

UNIT I Orientation
General Orientation on NSS/NCC/ Scouts & Guides/Community Service activities, career guidance.
Activities:

i) Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills
ii) Conducting orientations programs for the students –future plans-activitiesreleasing road map etc. iii) Displaying success stories-motivational biopics- award winning movies on societalissues etc.
iv) Conducting talent show in singing patriotic songs-paintings- any other contribution.

UNIT II Nature Care Activities:

i) Best out of waste competition.
ii) Poster and signs making competition to spread environmental awareness. iii) Recycling and environmental pollution article writing competition. iv) Organising Zero-waste day.
v) Digital Environmental awareness activity via various social media platforms.
vi) Virtual demonstration of different eco-friendly approaches for sustainable living.
vii) Write a summary on any book related to environmental issues.

UNIT III Community Service Activities:

i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities-experts-etc.
ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS, iii) Conducting consumer Awareness. Explaining various legal provisions etc. iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
v) Any other programmes in collaboration with local charities, NGOs etc.

Reference Books:

1. Nirmalya Kumar Sinha & Surajit Majumder, *A Text Book of National Service Scheme* Vol;.I, Vidya Kutir Publication, 2021 (ISBN 978-81-952368-8-6)
2. *Red Book - National Cadet Corps* – Standing Instructions Vol I & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis M. L. and Cornwell D. A., —Introduction to Environmental Engineering‖, McGraw Hill, New York 4/e 2008
4. Masters G. M., Joseph K. and Nagendran R. —Introduction to Environmental Engineering and Science‖, Pearson Education, New Delhi. 2/e 2007
5. Ram Ahuja. *Social Problems in India*, Rawat Publications, New Delhi.

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities.
2. Institutes are required to provide instructor to mentor the students.

Evaluation Guidelines:

1. Evaluated for a total of 100 marks.
2. A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalling to 90 marks.
3. A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

23MAX02 DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

(Common to All Branches of Engineering) 3 0 0 3

Course Outcomes:

At the end of the course, the student will be able to

1. Model and solve the first order differential equations
2. Experiment with the practical importance of solving first and higher order differential equations in engineering.
3. Solve higher order differential equations and understand about initial value problems
4. Identify methods for solving linear partial differential equations.
5. Make use of central concepts in partial differential equations and vector differentiation
6. Apply vector calculus in the context of estimating the work done, circulation, flux and vector integral theorems

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2								1		
CO2	3	2	3	3								1		
CO3	3	3	3	2								1		
CO4	3	2	2	1								1		
CO5	3	3	2	1								1		
CO6	3	3	3	2								1		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT- I :

Differential equations of first order and first degree

Linear differential equations – Bernoulli's equations- Exact equations and equations reducible to exact form. Applications: Newton's Law of cooling – Law of natural growth and decay- Electrical circuits

UNIT – II :

Linear differential equations of higher order (Constant Coefficients)

Definitions, homogenous and non-homogenous, complimentary function, general particular integral, Wronskean, method of variation of parameters. Simultaneous linear equations, Applications to L-C-R Circuit problems and Simple Harmonic motion.

UNIT – III : Partial Differential Equations

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method. Homogeneous Linear Partial differential equations with constant coefficients.

UNIT - IV : Vector Calculus

Vector differentiation:

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions - Divergence and Curl, vector identities

Vector integration:

Line integral- circulation- work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

Textbooks:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e,John Wiley & Sons, 2018.
2. B.S.Grewal,HigherEngineeringMathematics,44/e,Khanna publishers,2017.

Reference Books:

1. Dennis G.Zill and Warren S.Wright, Advanced Engineering Mathematics, Jones andBartlett, 2018.
2. Micheael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, PearsonPublishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha ScienceInternational Ltd., 2021 (9th reprint).

5. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Assessments
Remember	10	10	
Understand	60	60	40
Apply	30	30	60
Analyze			
Evaluate			
Create			
Total (%)	100	100	100

Sample Question (s)

Remember

1. State Newton's Law of Cooling
2. Find the Wronskian for the functions $cosx$ and $sinx$
3. Form the PDE by eliminating the arbitrary constants a and b from $z = ax + by + \frac{a}{b} - b$
4. State Gauss divergence theorem.

Understand

1. Solve $\left(1 + e^{x/y}\right)dx + e^{x/y}\left(1 - \frac{x}{y}\right)dy = 0$
2. Solve $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = 2e^{3x}$
3. Form the PDE by eliminating the arbitrary functions from $Z = f(x) + e^y g(x)$

Apply

1. A bacterial culture, growing exponentially, increases from 200 to 500 grams in the period from 6 a.m to 9 a.m. Find the number of grams which will be present at noon.
2. If a voltage of $20\cos 5t$ is applied to a series circuit consisting of 10 ohm resistor and 2 Henry inductor, determine the current at any time t.
3. Find the work done in moving a particle in the force field $F = 3x^2\bar{\imath} + (2xz - y)\bar{\jmath} + z\bar{k}$ along the straight line from (0,0,0) to (2,1,3).

23ME201 ENGINEERING MECHANICS
(Common to MECH & CIVIL)

3 0 0 3

Course Outcome:

1. Compute the resultant force in concurrent and coplanar force systems.
2. Analyze the equilibrium condition for different force systems with and without friction.
3. Determine the forces and their nature in the members of trusses.
4. Determine the centroids, centre of gravity and moment of inertia of different geometrical shapes.
5. Analyze the kinematics of rectilinear and curvilinear motions.
6. Assess the kinetics of rectilinear, curvilinear and rigid body motion.

CO-PO Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2										2	
CO2	3	2	2										2	
CO3	3	2	2										2	
CO4	3	2	2										2	
CO5	3	3	2										2	
CO6	3	3	2										2	

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT I: Introduction to Engineering Mechanics – Basic Concepts, Scope and Applications, Systems of Forces: Coplanar Concurrent Forces– Components in Space–Resultant– Moment of Force and its Application –Couples and Resultant of Force Systems.
Friction: Introduction, limiting friction and impending motion, Coulomb's laws of dry friction, coefficient of friction, Cone of Static friction. **12 hours**

UNIT II: Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorem, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Analysis of plane trusses by method of joints and sections. **12 hours**

UNIT III: Centroid and Centre of Gravity: Centroids of simple figures (from basic principles)–Centroids of Composite Figures. Centre of gravity of composite bodies,
Area Moments of Inertia: Definition– Polar Moment of Inertia, Parallel and perpendicular axis theorems, Moments of Inertia of Composite Figures. **12 hours**

UNIT IV: Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics –D'Alembert's Principle - Work Energy method and applications to particle motion-Impulse Momentum method.
Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method. **12 hours**

Total: 48 hours

Textbooks:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022

Reference Books:

1. Engineering Mechanics, Statics and Dynamics, Rogers and M A. Nelson., McGraw Hill Education.
2. Engineering Mechanics, S.S Bhavikatti, 8th Edition, New Age International, 2022.
3. Engineering Mechanics, A.K Tayal, Statics and Dynamics, 14th Edition, Umesh Publishers, 2021
4. Engineering Mechanics: Principles of Statics and Dynamics, R.C. Hibbler., Pearson Press, 2006.
5. Introduction to Statics and Dynamics, Andy Ruina and Rudra Pratap., Oxford University Press, 2011.

Sample Questions(s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	15	15	-
Understand	30	30	-
Apply	55	55	70
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

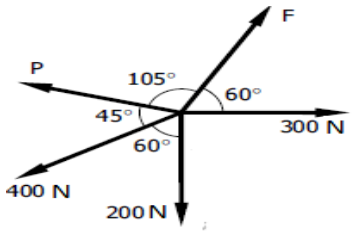
1. Name different types of system of forces
2. Define centroid
3. Define area moment of inertia
4. State the laws of friction
5. List the assumptions of perfect frame
6. Define Rectilinear and Curvilinear motions

Understand

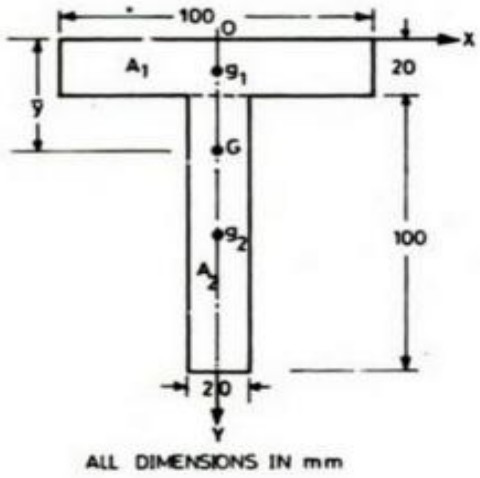
1. Explain Lami's theorem
2. Compare centroid and centre of gravity
3. Explain about area moment of inertia
4. How will you distinguish between static friction and dynamic friction?
5. Explain the difference between frame and truss
6. Explain the D Alembert's principle

Apply

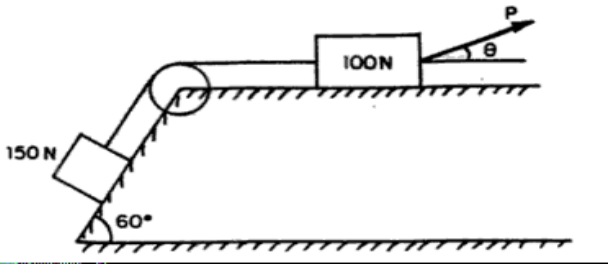
1. Figure represents the concurrent force system acting at a joint of a bridge truss. Determine the value of P and E to maintain equilibrium of the forces



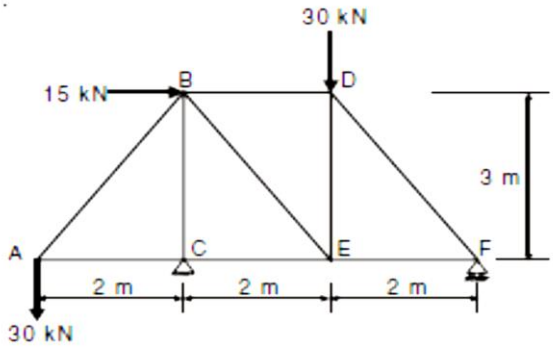
2. Identify the centroid of T-section shown in below Fig.



3. Determine the moment of inertia of the areas of Triangle bout its base by first principle
4. Determine the least value of force P to cause motion to impend rightwards. Assume the co-efficient of friction under the blocks to be 0.2 and pulley to be frictionless.



5. Determine the forces in all the members of the truss shown in Fig.



6. A stone is dropped into a well and the splash is heard two seconds later. If sound travels 335m/s, what is the depth of the well?

7. An 1800 kg Toyota Innova travels down the 10° inclined road at a speed of 6 m/s. If the driver jams on the brakes, causing his wheels to lock, solve how far the tires skid on the road using: a. Equation of the motion b. Principles of work-Energy The coefficient of kinetic friction between the wheels and the road is 0.5 **(For Open Book Examination and not for semester end examination)**

Analyze

1. A uniform ladder 3 m long weighs 200 N. It is placed against a wall making an angle of 60° with the floor as shown in Fig. The coefficient of friction between the wall and the ladder is 0.25 and that between the floor and ladder is 0.35. The ladder, in addition to its own weight, has to support a man of 1000 N at its top at B. Calculate: i) The horizontal force P to be applied to ladder at the floor level to prevent slipping. ii) If the force P is not applied, what should be the minimum inclination of the ladder with the horizontal, so that there is no slipping of it with the man at its top?
2. Compare the location of the centroids of an arc of circle and a sector of a circle subtending the same angle at the centre of the circle
3. A car A is travelling on a straight level road with a uniform speed of 60 km/hr. it is followed by another car B moving at a speed of 70 km/hr. when the distance between them is 2.5 km, the car B is decelerated at 20 km/ hr^2. will the car be catch up with A? if not, why not? If yes, at what distance and time?
4. Analyze the ability of a hook (used by a crane) to raise prefabricated walls upright. The hook was approximately J-shaped, with a lip. The hook would grip one end of the wall and lift, while the other end of the wall remained in contact with the ground **(For Open Book Examination and not for semester end examination)**
6. The car A has a forward speed of 18 km/h and is accelerating at 3 m/s^2 Determine the velocity and acceleration of the car relative to observer B, who rides in a nonrotating chair on the Ferris wheel. The angular rate ω = 3 rev/min of the Ferris wheel is constant **(For Open Book Examination and not for semester end examination)**

(Common for CSE, CSE-AI&DS, CSE-AI&ML, IT)

23CS201 Data Structures

3 0 0 3

Course Outcomes

At the end of the course, Student will be able to

1. Explain the role of linear data structures in organizing and accessing data efficiently in algorithms.
2. Design, implement, and apply linked lists for dynamic data storage, demonstrating understanding of memory allocation.
3. Develop programs using stacks to handle recursive algorithms, manage program states, and solve related problems.
4. Apply queue-based algorithms for efficient task scheduling and breadth-first traversal in graphs and distinguish between deques and priority queues, and apply them appropriately to solve data management challenges.
5. Devise novel solutions to small scale programming challenges involving data structures such as stacks, queues, Trees
6. Recognize scenarios where hashing is advantageous, and design hash-based solutions for specific problems.

CO-PO Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2									1	3	
CO2	3	3	3									1	3	
CO3	3	3	3									1	3	
CO4	3	3	3									1	3	
CO5	3	3	3									1	3	
CO6	2	3	3									1	3	

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Linear Data Structures: Definition and importance of linear data structures, Abstract data types (ADTs) and their implementation, Overview of time and space complexity analysis for linear data structures.
Searching Techniques: Linear & Binary Search, **Sorting Techniques**: Bubble sort, Selection sort, Insertion Sort

11Hours

Unit II

Linked Lists and Stacks: Singly linked lists, representation and operations, doubly linked lists and circular linked lists, Comparing arrays and linked lists, Applications of linked lists. **Stacks**: Introduction to stacks: properties and operations, implementing stacks using arrays and linked lists, **13 Hours**

Unit III

Queues: Introduction to queues: properties and operations, implementing queues using arrays and linked lists. Deques: Introduction to deques (double-ended queues), Operations on deques and their applications**. Applications of Stack and Queue:** Applications of stacks in expression evaluation, backtracking, reversing list etc., Applications of queues in breadth-first search, scheduling, etc. **12 Hours**

Unit IV

Trees: Introduction to Trees, Binary Search Tree – Insertion, Deletion & Traversals Hashing: Brief introduction to hashing and hash functions, Collision resolution techniques: chaining and open addressing, Hash tables: basic implementation and operations, Applications of hashing in unique identifier generation, caching, etc.

12 Hours

Total: 48 Hours

Textbooks:

1. Data Structures and algorithm analysis in C, Mark Allen Weiss, Pearson, 2nd Edition.

2. Fundamentals of data structures in C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, Silicon Press, 2008

Reference Books:

1. Algorithms and Data Structures: The Basic Toolbox by Kurt Mehlhorn and Peter Sanders
2. C Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, and John E. Hopcroft
3. Problem Solving with Algorithms and Data Structures" by Brad Miller and David Ranum
4. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
5. Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms" by Robert Sedgewick

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Assessments
Remember	25	25	
Understand	38	38	
Apply	37	37	
Analyze	--		30
Evaluate	--		25
Create	--		45
Total (%)	100	100	100

Sample Question (s)

Remember

1. Compute the time complexity of insertion in a linked list.
2. Define Abstract Data Type (ADT)?
3. Define a linear data structure and give one example.

Understand

1. How does the implementation of ADTs benefit software development?
2. What is the time complexity of a linear search in the worst case?
3. Differentiate between stack and queue.

Apply

1. Describe the process of implementing an ADT for a stack.
2. Draw the logical structure of a doubly linked list.

23EE201 Electrical Circuit Analysis-1(For EEE Branch)

3 0 0 3

Course Outcomes

At the end of the course, Student will be able to

1. Summarize the V-I relations of electrical circuit elements.
2. Outline magnetic and couple circuits
3. Apply network reduction techniques to DC circuits
4. Summarize the behaviour of AC circuits
5. Apply network theorems to AC and DC circuits.
6. Outline the characteristics of series/parallel resonant circuits

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**1**	**2**									**3**	**2**	**1**
CO2	**2**	**1**	**2**									**3**	**2**	**1**
CO3	**3**	**2**	**3**									**3**	**3**	**2**
CO4	**2**	**1**	**2**									**3**	**2**	**1**
CO5	**3**	**2**	**3**									**3**	**3**	**2**
CO6	**2**	**1**	**2**									**3**	**2**	**1**

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT-I: Introduction to Electrical Circuits

Basic circuit elements R, L, C and their V-I relations, dependent and independent sources, Kirchoff's laws, Network reduction techniques (series, parallel, series - parallel, star-to-delta and delta-to-star transformation, source transformation), nodal and mesh analysis to DC networks with dependent and independent voltage and current sources *supernode and supermesh analysis* **(12 Hours)**

UNIT-II: Magnetic Circuits

Terminology used in magnetic circuits, series, parallel and composite magnetic circuits, analogy between electrical and magnetic circuits, Faraday's laws of electromagnetic induction – concept of self and mutual inductance, Dot convention – coefficient of coupling.

Conductively coupled equivalent circuit **(10 Hours)**

UNIT-III: Single Phase Circuits

Characteristics of periodic functions, Average value, R.M.S. value, form factor, peak factor, and representation of a sine function, concept of phasor, phasor diagram.

Steady state analysis of R, L and C circuits to sinusoidal excitations-response of pure resistance, inductance, capacitance, series RL, RC and RLC circuits, parallel RL, RC and RLC parallel circuits, power and power factor

Resonance: Series Resonance-Characteristics of a series resonant circuit, Q-factor, selectivity and bandwidth, expression for half power frequencies; Parallel resonance- Q-factor, selectivity and bandwidth.

Locus diagram: RL, RC, RLC series circuits with R, L and C variables.

Comparison between series and parallel resonance, applications of resonant circuits **(15 Hours)**

UNIT-IV: Network theorems (DC & AC Excitations)

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem an Millman's theorem and compensation theorem.

Tellegen's theorem **(11 Hours)**

(Total: 48 Hours)

Textbook (s)

1. W.H.Hayt, J.E.Kimmerly, and S.M.Durbin, "*Engineering Circuit Analysis*", Tata McGraw Hill, 8th Edition, 2015.

2. Charles K Alexander and Mathew N.O Sadiku, "*Fundamentals of Electric Circuits*", Tata McGraw Hill, 5th Edition, 2013.
3. M.E Van Valkenburg, "*Network Analysis*", Prentice Hall of India, 4th Edition, 2018.
4. P. Ramana, G.T.Chnadra Sekhar, G.Suresh, "*Network Theory*", SChand and Company Ltd., 1st Edition, 2024.

Reference (s)

1. Abhijit Chakrabarti, "*Circuit Theory Analysis and Synthesis*", Dhanpat Rai & Co., 6th Edition, 2014.
2. A Sudhakar, and Shyammohan S. Palli, "*Circuits and Networks: Analysis and Synthesis*", McGraw Hill Higher Education, 5th Edition, 2015.
3. M Nahvi, Joseph Edminister, K Uma Rao, "Electric Circuits, (Schaum's Outline Series)", McGraw Hill Higher Education, 7th Edition, 2017.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Assignment Test(%)
Remember	20	20	-
Understand	20	20	-
Apply	60	60	60
Analyze	-	-	40
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

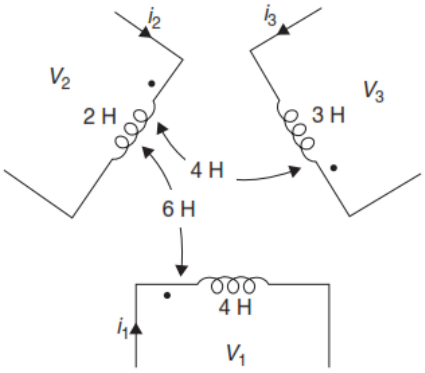
1. When a 25 Ω resistor, 100 Ω resistor, 75Ω resistor and 50 Ω resistor are connected in parallel, then find the total resistance of the circuit.
2. Define statically induced emf.
3. List the limitations of Millman's theorem
4. State superposition theorem.
5. Define Quality factor and bandwidth.

Understand

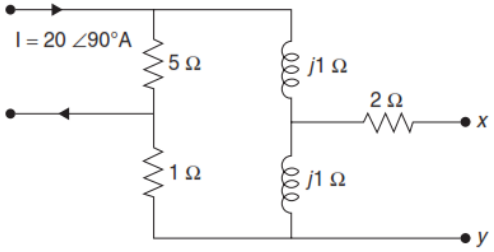
1. Find the two elements in a series circuit, given that the current and total voltage are
   $i = 10\cos(5000\,t - 23.13^0)\,A,\;\; v = 50\cos(5000\,t + 30^0)\,V$
2. When two coils are connected in series their effective inductance is found to be 10 H. When the connection of one coil is reversed, the effective inductance is 6 H. If the coefficient of coupling is 0.6, calculate the self inductance of each coil and the mutual inductance.
3. State dot rule for coupled coils and explain its significance.

Apply

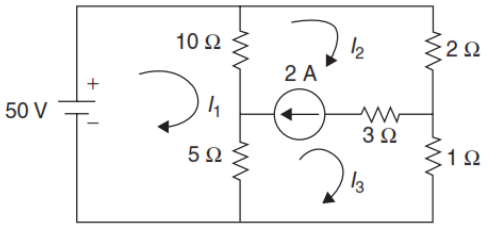
1. For the circuit as shown in the figure, write the inductance matrix.



2. Find the power consumed by a load of $5\angle 60^0\,\Omega$ connected between terminals x and y in the circuit as shown in the figure, using Thevenin's theorem.



3. Determine the current in the 5 Ω resistor in the network shown in the figure.



23EC201 Network Analysis (ECE Branch)

3 0 0 3

Course Outcomes

At the end of the course, Student will be able to

1. Apply network reduction techniques to DC circuits.
2. Apply network theorems to simplify complex networks.
3. Summarize the behavior of AC circuits.
4. Explain series and parallel connected coupled circuits.
5. Interpret various parameters for a given two-port network.
6. Illustrate the transient response of R, L, C circuits for DC and AC excitations.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**3**	**2**	**3**									**3**		
CO2	**3**	**2**	**3**									**3**		
CO3	**2**	**1**	**2**									**3**		
CO4	**2**	**1**	**2**									**3**		
CO5	**2**	**1**	**2**									**3**		
CO6	**2**	**1**	**2**									**3**		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT-I

Introduction to Electrical Circuits and Network theorems

Introduction to Electrical Circuits: Types of circuit elements, types of sources, ohm's law, Kirchoff's laws, source transformation, star-delta conversion, mesh and nodal analysis, problem solving with resistances, principal of duality with examples.

Network Theorems: Superposition, Thevenin's, Norton's, Millman's, Reciprocity, Compensation, Substitution, Max Power Transfer, Tellegen's theorems.

13 Hours

UNIT-II

Steady state AC analysis and Resonance

Steady State AC Analysis: Impedance concept, j-operator, phasor notation, RL, RC, RL C circuits problem solving, calculation of different powers and power factor.

Resonance: Definition of resonance, series resonance, parallel resonance, bandwidth, quality factor of series and parallel resonance.

11 Hours

UNIT-III

Coupled Circuits and Two Port Networks

Coupled Circuits: Faraday's laws of electromagnetic induction, self-inductance, mutual inductance, coefficient of coupling, dot rule of coupled circuits, conductively coupled equivalent circuits- problem solving.

Two-port Networks: Z-parameters, Y-parameters, Transmission line parameters, h- parameters, Interrelationship between parameters, Interconnection of two port networks.

12 Hours

UNIT-IV

Transient Analysis

Transients: First order differential equations, Definition of time constants, RL circuit, RC circuit with DC excitation, evaluating initial conditions procedure, second order differential equations, problem-solving using RLC elements with DC excitation and AC excitation, Response of second order circuit as related to location of poles in s-plane.

Laplace transforms: introduction to Laplace transformation, problem solving using Laplace transform,

12 Hours

Total: 48 Hours

Textbook (s)

1. W.H.Hayt, J.E.Kimmerly, and S.M.Durbin, "*Engineering Circuit Analysis*", Tata McGraw Hill, 8th Edition, 2015.
2. Charles K Alexander and Mathew N.O Sadiku, "*Fundamentals of Electric Circuits*", Tata McGraw Hill, 5th Edition, 2013.
3. M.E Van Valkenburg, "*Network Analysis*", Prentice Hall of India, 4th Edition, 2018.

4. P. Ramana, G.T.Chnadra Sekhar, G.Suresh, "*Network Theory*", SChand and Company Ltd., 1st Edition, 2024.

Reference (s)

1. Abhijit Chakrabarti, "*Circuit Theory Analysis and Synthesis*", Dhanpat Rai & Co., 6th Edition, 2014.
2. A Sudhakar, and Shyammohan S. Palli, "*Circuits and Networks: Analysis and Synthesis*", McGraw Hill Higher Education, 5th Edition, 2015.
3. M Nahvi, Joseph Edminister, K Uma Rao, "Electric Circuits, (Schaum's Outline Series)", McGraw Hill Higher Education, 7th Edition, 2017.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Exam(%)
Remember	10	10	
Understand	30	30	
Apply	60	60	70
Analyze			20
Evaluate			10
Create			
Total (%)	100	100	100

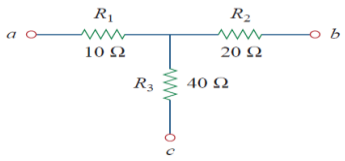
Sample Question (s)

Remember

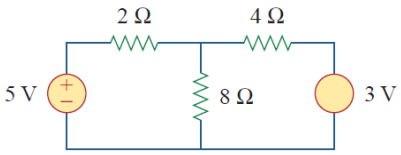
1. Define Kirchhoff of current law
2. Define Thevenin Theorem
3. Define Superposition theorem
4. Define time constant of a RL circuit

Understand

1. Convert the below Star network to Delta network.



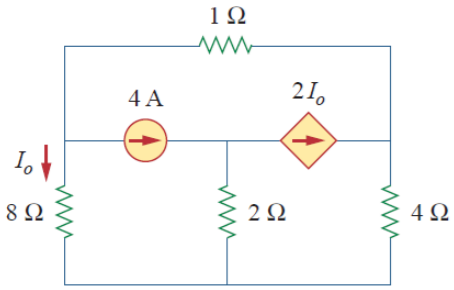
2. What is the Voltage across 8Ω resistor



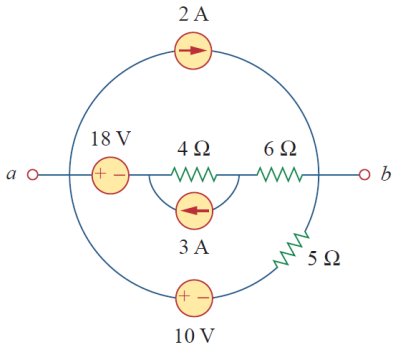
3. An incandescent lamp draws 2 A at 100 V. Find its resistance

Apply

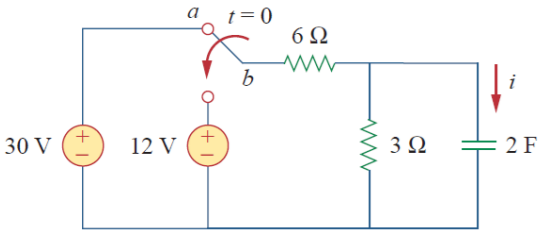
1. Find the value of voltage across 2Ω resistor by using Thevenin's theorem.



2. Find the Thevenin equivalent circuits at terminals ***a-b.***



3. The switch in circuit has been in position *a* for a long time. At t=0, it moves to position *b*. Calculate $i(t)$ for all $t > 0$.



(Common for CSE, CSE-AI&DS, CSE-AI&ML, IT)
23CS202 Data Structures Lab

0 0 3 1.5

Course Outcomes

At the end of the course, Student will be able to

- Explain the role of linear data structures in organizing and accessing data efficiently in algorithms.
- Design, implement, and apply linked lists for dynamic data storage, demonstrating understanding of memory allocation.
- Develop programs using stacks to handle recursive algorithms, manage program states, and solve related problems.
- Apply queue-based algorithms for efficient task scheduling and breadth-first traversal in graphs and distinguish between deques and priority queues, and apply them appropriately to solve data management challenges.
- Devise novel solutions to small scale programming challenges involving data structures such as stacks, queues, Trees
- Recognize scenarios where hashing is advantageous, and design hash-based solutions for specific problems.

CO-PO Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	3	2								1	3	
CO2		2	3	2								1	3	
CO3		2	3	2								1	3	
CO4		2	3	2								1	3	
CO5		2	3	2								1	3	
CO6		2	3	2								1	3	

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments:

1. Array Manipulation
    a. Write a program to reverse an array.
    b. Basic Array Programs
2. Searching Techniques
    a. C Programs to implement the Searching Techniques – Linear
    b. C Programs to implement the Searching Techniques - Binary Search
3. Sorting Techniques
    a. C Programs to implement Sorting Techniques – Bubble Sort
    b. C Programs to implement Sorting Techniques - Insertion Sort
4. Linked List Implementation
    a. Implement a singly linked list and perform insertion and deletion operations.
    b. Develop a program to reverse a linked list iteratively and recursively.
5. Linked List Applications
    a. Create a program to detect and remove duplicates from a linked list.
    b. Implement a linked list to represent polynomials and perform addition.
6. Double and Circular Linked List Implementation
    a. Implement a doubly linked list and perform various operations to understand its properties and applications.
    b. Implement a circular linked list and perform insertion, deletion, and traversal.
7. Stack Operations
    a. Implement a stack using arrays
    b. Implement a stack using linked lists
8. Queue Operations
    a. Implement a queue using arrays
    b. Implement a queue using linked lists
9. Queue Types
    a. Implement a circular queue

b. Implement a double-ended queue (deque) with essential operations.

10. Stack Applications -I
    a. Use a stack to convert an infix expression to postfix
    b. Write a program to evaluate a postfix expression using a stack.
11. Stack Applications -II
    a. Implement a program to check for balanced parentheses using a stack.
    b. Create a program to determine whether a given string is a palindrome or not.
12. Queue Applications
    a. Develop a program to simulate a simple printer queue system.
    b. Implement a stack or queue to perform comparison and check for symmetry
13. Binary Search Tree
    a. Implementing a BST using Linked List.
    b. Traversing of BST.
14. Closed Hashing: Implement a hash table with open Addressing techniques.
15. Open Hashing: Implement a hash table with Separate chaining techniques.
16. Hashing- Application: Write a program to implement a simple cache using hashing.

Indicative list of applications-based experiments

1. **Integer to Roman**
   Problem Description: Given an integer, convert it to a Roman numeral. Input is guaranteed to be within the range from 1 to 3999.
   Implementation: You can create a function that iteratively subtracts the largest possible Roman numeral values from the given integer and appends the corresponding symbols until the integer becomes zero.
2. **Merge Two Sorted Linked Lists**
   Problem Description: Merge two sorted linked lists and return it as a new sorted list.
   Implementation: Create a function that takes two sorted linked lists as input and iteratively compares the nodes, merging them into a new sorted linked list.
3. **Task Scheduler**
   Problem Description: Given a character array representing tasks, each task is represented by a character. Tasks could be done without the original order. Each task is done in one unit of time. For each unit of time, any CPU can execute at most one task. Given the character array, find the minimum time required to finish all the tasks.
   Implementation: Implement a function that schedules the tasks efficiently based on their frequencies and calculates the minimum time required.
4. **Find the kth Smallest or Largest Element in a BST**
   Problem Description: Given a binary search tree, find the kth smallest or largest element in it.
   Implementation: Write a function that performs an in-order traversal of the BST while keeping track of the count of visited nodes. Return the kth element when the count matches k.
5. **Construct BST from Preorder or Postorder Traversal**
   Problem Description: Given an array representing either the preorder or postorder traversal of a binary search tree, construct the tree.
   Implementation: Create a function that recursively builds the binary search tree using the given traversal order.
6. **Binary Tree Level Order Traversal**
   Problem Description: Given a binary tree, return the level order traversal of its nodes' values. (i.e., from left to right, level by level).
   Implementation: Implement a function that performs a level order traversal using a queue to keep track of each level.
7. **Checking for Anagram Pairs using Hash Table**
   Problem Description: Given an array of strings, group anagrams together.
   Implementation: Create a function that uses a hash table to group anagrams. Anagrams will have the same sorted characters, which can be used as keys in the hash table.
8. **Check if the Tree is Balanced**
   Problem Description: Given a binary tree, determine if it is height-balanced.
   Implementation: Write a function that calculates the height of each subtree and checks if the difference in heights between left and right subtrees is within one.

0 0 3 1.5

Course Outcomes:

1. Demonstrate knowledge of the principles governing the Law of forces and validate them through experimental setups
2. Execute the experiments to achieve equilibrium in coplanar-concurrent force system
3. Asses the significance of friction in mechanical systems.
4. Check the equilibrium of objects subjected to diverse forces, delve into rotational dynamics, and apply principles of conservation laws
5. Apply the principles of static equilibrium to analyse coplanar non-concurrent, parallel force systems
6. Apply the principle of mechanics to system of pulleys, compound pendulum and Bell-crank lever

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2		2			3	2			2	
CO2	3			2		2			3	2			2	
CO3	3			2		2			3	2			2	
CO4	3			2		2			3	2			2	
CO5	3			2		2			3	2			2	
CO6	3			2		2			3	2			2	

Students have to perform any 10 of the following Experiments:

List of Experiments:

1. Verification of Law of Parallelogram of Forces.
2. Verification of Law of Triangle of Forces.
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium using universal force table.
4. Determination of coefficient of Static and Rolling Frictions
5. Determination of Centre of Gravity of different shaped Plane Lamina.
6. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non- concurrent, parallel force system with the help of a simply supported beam.
7. Study of the systems of pulleys and draw the free body diagram of the system.
8. Determine the acceleration due to gravity using a compound pendulum.
9. Determine the Moment of Inertia of the compound pendulum about an axis perpendicular to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.
11. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever.

References:

1. Engineering Mechanics Lab manual.
2. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
3. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022.

List of Augmented Experiments

1. Prepare a couple for any engineering application
2. Prepare a truss and draw a FBD for it
3. Find the centroid of a composite plane
4. Prepare a demonstrative model for different force systems
5. Analysis of Projectile Motion: Launch projectiles at different angles and measure their range, height, and time of flight. With an Objective: Verify the equations of motion for projectiles and determine the effect of launch angle on range and maximum height.

23EC202 Network Analysis and Simulation Lab (ECE)

0 0 3 1.5

Course Outcomes:

At the end of the course, Student will be able to

1 Illustrate Kirchhoff's laws, mesh, and nodal analysis for DC circuits
2 Make use of network theorems to simplify the electrical circuits
3 Analyze the DC Transients of RL & RC circuits
4 Demonstrate the characteristics of series RL, RC circuits
5 Demonstrate the characteristics of series RLC circuits and resonant circuit for given specifications
6 Characterize and model the network in terms of all network parameters

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**1**		**1**	**2**				**2**			**3**		
CO2	**3**	**2**		**2**	**3**				**3**			**3**		
CO3	**3**	**3**		**2**	**3**				**3**			**3**		
CO4	**3**	**2**		**3**	**3**				**3**			**3**		
CO5	**3**	**2**		**3**	**3**				**3**			**3**		
CO6	**3**	**2**		**2**	**3**				**3**			**3**		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

SYLLABUS:

The following experiments need to be performed using Simulation Software.

1. Verification of KCL and KVL for DC circuits.
2. Verification of mesh and nodal analysis for DC circuits
3. Verification of Superposition theorems for DC circuits
4. Verification of Thevenin's and Norton's theorems for DC circuits
5. Verification of Maximum power transfer theorem for DC circuits
6. Determination of Impedance and Power factor of Series RL & RC circuits
7. Determination of Active, reactive, and apparent power of Series RL & RC circuit
8. Determination of Impedance, Power factor, Active, Reactive, and Apparent power of a series RLC circuit
9. Construct a Series Resonance circuit to find the Q Factor and Bandwidth
10. Construct a Parallel Resonance circuit to find the Q Factor and Bandwidth
11. Determination of open circuit (Z) and short circuit (Y) parameters
12. Determination of hybrid (H) and transmission (ABCD) parameters
13. Analysis of DC transients in Series RL and Parallel RL circuits
14. Analysis of DC transients in Series RC and Parallel RC circuits
15. Analysis of DC transient and steady-state response of a 2nd order circuit by varying itsvarious parameters and studying their effects on responses.

Textbook (s):

1. M.E Van Valkenburg, Network Analysis, Prentice Hall of India, 3rd Edition, 2015
2. W.H.Hayt, J.E.Kimmerly, and S.M.Durb, Engineering circuit analysis, McGraw Hill Education private limited, 8th Edition, 2013

Software requirements:

Multisim/ Pspice/Orcad Equivalent simulation software tool, Computer Systems with requiredspecifications

References:

1. Network Analysis ME Van Valkenburg, Prentice Hall of India, revised 3rd Edition,2019.

Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips,Steven M. Durbin, 9th Edition 2020

23EE202 Electrical Circuit Lab -EEE

Course Outcomes:

At the end of the course, Student will be able to

1. Demonstrate network reduction techniques using basic laws.
2. Compute the parameters of electrical equipment
3. Compute the parameters of magnetic circuit
4. Analyse series and parallel resonant circuits
5. Analyse maximum Power transfer from source to load
6. Apply network theorems to solve electrical circuits

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**2**	**1**		**1**	**2**				**2**			**3**	**2**	
CO2	**3**	**2**		**2**	**3**				**3**			**3**	**3**	
CO3	**3**	**2**		**2**	**3**				**3**			**3**	**3**	
CO4	**3**	**3**		**3**	**3**				**3**			**3**	**3**	
CO5	**3**	**3**		**3**	**3**				**3**			**3**	**3**	
CO6	**3**	**2**		**2**	**3**				**3**			**3**	**3**	

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

List of Experiments

S.No	Name of Experiment	COs
	CYCLE 1 (Hardware)	
1	Verification of Kirchhoff's circuit laws.	CO1
2	Determination of self, mutual inductances, and coefficient of coupling.	CO3
3	Determination of Parameters of a choke coil.	CO2
4	Verification of Superposition theorem	CO6
5	Series and parallel resonance	CO4
	CYCLE 2 (Simulation)	
1	Verification of node and mesh analysis	CO1
2	Verification of Thevenin's and Norton's Theorems	CO6
3	Verification of Maximum power transfer theorem	CO5
4	Verification of Compensation theorem	CO6
5	Verification of Reciprocity and Millman's Theorems	CO6

List of Augmented Experiments:

1. Locus diagrams of R-L(L Variable) and R-C (C Variable) series circuits
2. Verification of network reduction techniques.
3. Determination of cold and hot resistance of an electric lamp
4. Determination of resonance frequency for a parallel tank circuit.
5. Verification of tellegan's theorem.

Reference Books:

1. W.H.Hayt, J.E.Kimmerly, and S.M.Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 8th Edition, 2015.
2. Charles K Alexander and Mathew N.O Sadiku, "Fundamentals of Electric Circuits", Tata McGraw Hill, 5th Edition, 2013.
3. M.E Van Valkenburg, "Network Analysis", Prentice Hall of India, 4th Edition, 2018.
4. P. Ramana, G.T.Chnadra Sekhar, G.Suresh, "Network Theory", SChand and Company Ltd., 1st Edition, 2024.

23CE201 ENGINEERING MECHANICS & BUILDING PRACTICES LAB-CIVIL

0-0-3-1.5

Course Outcomes:

At the end of the course, the student will be able to

1. Evaluate the coefficient of friction between two different surfaces and between the inclined plane and the roller.
2. Verify Law of Parallelogram of forces and Law of Moment using force polygon and bell crank lever.
3. Determine the Centre of gravity different configurations
4. Understand the Quality Testing and Assessment Procedures
5. Understand the principles of Non- Destructive Testing.
6. Exposure to safety practices in the construction industry.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					2		3	3	2				
CO2	3					2		3	3	2				
CO3	3					2		3	3	2				
CO4	3					2		3	3	2				
CO5	3					2		3	3	2				
CO6	3					2		3	3	2				

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Students have to perform any 10 of the following Experiments:

List of Experiments:

1. To study various types of tools used in construction.
2. Forces in Pin Jointed Trusses
3. Experimental Proof of Lami's Theorem
4. Verification of Law of Parallelogram of Forces.
5. Determination of Center of Gravity of different shaped Plane Lamina.
6. Determination of coefficient of Static and Rolling Friction.
7. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever
8. Study of Alternative Materials like M-sand, Fly ash, Sea Sand etc.
9. Field-Visit to understand the Quality Testing - report.
10. Safety Practices in Construction industry
11. Demonstration of Non-Destructive Testing - using Rebound Hammer & UPV
12. Study of Plumbing in buildings.

References:

1. Engineering Mechanics and Building Practices Lab manual.
2. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
3. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022.

23MA302 Engineering Mathematics III

(Programmes: EEE, MECH, CHEM)

3 0 2 4

Course Outcomes

1. Utilize numerical methods to find approximate solutions of equations and to find the best fit curve for given data
2. Make use of the concepts of interpolation to estimate the unknown functional values
3. Find approximate values of finite integrals and solution of ODE using numerical techniques
4. Interpret Baye's theorem and probability distribution functions to solve engineering problems
5. Identify the suitable distribution among Binomial, Poisson and Normal in engineering applications
6. Apply the concept of correlation between the variables and also construct the regression lines

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2						2	2	2
CO2	3	3	3	2	2	2						2	2	2
CO3	3	3	3	2	2	2						2	2	2
CO4	3	2	2	3	2	2						2	2	2
CO5	3	2	2	3	3	2						2	2	2
CO6	3	2	2	3	3	2						2	2	2

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Solution of Algebraic and Transcendental Equations

Introduction, Bisection Method, Method of False Position, Newton-Raphson Method

Curve fitting-Fitting a straight line, Second degree curve, exponential curve, power curve by method of least squares

Geometrical interpretation - Bisection Method, Method of False Position, Newton-Raphson Method

Practical components

1. The Bisection method
2. Newton-Raphson Method
3. Linear Regression (Fitting of a straight line)

12 +8 Hours

Unit II

Interpolation, Numerical Integration and Numerical solution of Ordinary differential equations

Introduction, Finite differences, Newton's- forward and backward differences, Symbolic relations

Numerical Integration-Trapezoidal rule, Simpson's 1/3 Rule

Numerical Solution of Ordinary Differential equations: Solution by Taylor's series, Euler's, Modified Euler's Method, Runge-Kutta Methods

Milne's Predictor-Corrector Method

Practical components

1. Trapezoidal rule
2. Simpson's 1/3 Rule
3. Solution of Initial Value Problem using Taylor's series method
4. Solution of Initial Value Problem using Runge-Kutta Method of order four

12 +8 Hours

Unit III

Probability and Random variables

Probability, axioms of probability, Conditional probability, Baye's theorem

Random variables-Discrete and continuous Distributions and properties, Mathematical expectation, MGFs

Addition, Multiplication theorems of probability

Practical components

1. Baye's Rule

12 + 8 Hours

Unit IV

Probability Distributions, Correlation and Regression

Binomial, Poisson and Normal distribution – related properties
Correlation- Pearson's correlation coefficient and Spearman's Rank correlation coefficient, linear Regression (construction of Regression lines)
Correlation of grouped data, curvilinear regression

Practical components

1. Normal Distribution
2. Correlation related problems

12 + 8 Hours
Total: 48+32=80 Hours

Textbook (s)

1. B. S. Grewal, Higher Engineering Mathematics, 44th ed., Khanna Publishers, New Delhi, 2017
2. B. V. Ramana, Engineering Mathematics, 4th ed., Tata Mc Graw Hill, 2018
3. Engineering Mathematics-III lab manual-Mathematics Department (BS&H) - GMRIT, Rajam

Reference (s)

1. T. K.V. Iyengar, S.Ranganatham, B.Krishna Gandhi, *Mathematical Methods*, 2nd ed., S.Chand Co., New Delhi, 2006
2. T. K. V. Iyengar, K.B. Gandhi, *Probability and Statistics*, S. Chand Co., New Delhi, 2012
3. Ervin Kreyszig, *Advanced Engineering Mathematics*, 9th ed., Wiley India Pvt. Ltd., 2012
4. S. S. Sastry, *Introductory methods of Numerical Analysis*, 4th ed., Prentice Hall of India Pvt. Ltd., 2006
5. Engineering Mathematics-III Lab Manual - Mathematics Department (BS&H) - GMRIT, Rajam.
6. https://www.scilab.org/tutorials

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	10	10
Understand	30	30
Apply	60	60
Analyze	-	-
Evaluate	-	-
Create	-	-
Total (%)	100	100

Sample question (s)

Remember

1. Identify the root lies between which values for $x^3 - 5x + 1 = 0$.
2. State the Axioms of probability.

Understand

1. Prove that $\mu = \frac{1}{2}(E^{\frac{1}{2}} + E^{-\frac{1}{2}})$.
2. Show that the mean and variance are equal for Poisson distribution.

Apply

1. Given $y' = x^2 - y$, $y(0) = 1$, find $y(0.1)$, by using Euler's method.
2. In a bolt factory machines A, B, C manufacture 20%, 30% and 50% of the total of their output and 6%, 3% and 2% are defective. A bolt is drawn at random and found to be defective. Calculate the probabilities that it is manufactured from (i) machine A, (ii) machine B.

Analyze

1. Analyze the roots of the equation $x^2 - 2x + 3 = 0$ by drawing its curve.
2. Assume wireless sets are manufactured with 25 soldered joints each on the average one joint in 500 is defective. How many sets can be expected to be free from defective joints in a consignment of 10,000 sets.

Evaluate

1. Compare the procedures of N-R method and R-F method.
2. Determine the probability of getting at least i) 7 heads ii) 6 heads, when 10 coins are tossed simultaneously.

23EE302 DC Machines and Transformers

3 0 0 3

Course Outcomes

1. Illustrate the constructional features and working of DC machine
2. Outline the various starting, speed control and testing methods of DC motors
3. Analyze the performance of DC machine
4. Illustrate the constructional features and working of transformer
5. Outline the testing methods of transformer
6. Analyze the performance of transformer

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1									3	3	2
CO2	2	1	1									3	3	2
CO3	3	3	2									3	3	3
CO4	2	1	1									3	2	1
CO5	2	1	1									3	2	1
CO6	3	3	2									3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

DC Generators

DC Machine-constructional features - principle of operation, EMF equation, methods of excitation – circuit model, armature reaction - effects of armature reaction - cross magnetizing and de-magnetizing AT/pole, commutation, power flow equation - losses - constant & variable losses, build-up of EMF - OCC and load characteristics of shunt, series and compound generators, parallel operation of DC shunt generators, applications of DC generators

Purpose of equalizer rings and dummy coils

12 Hours

Unit II

DC Motors

DC Motors - principle of operation, types of DC Motors, torque equation, characteristics and application of shunt, series and compound motors, speed control of DC Motors - armature voltage and field flux control methods, three-point starter, Brake test, Swinburne's test, Hopkinson's test

Four-point starters and Retardation test

12 Hours

Unit III

Single Phase Transformers

Single phase transformers – types, constructional details, Ideal Transformer, EMF equation, operation at no-load and load, practical Transformer, phasor diagrams, equivalent circuit, losses and efficiency, regulation, OC and SC tests, all day efficiency, applications, parallel operation of transformers with equal voltage ratios.

Parallel operation of transformers with unequal voltage ratios

12 Hours

Unit IV

Auto-Transformers and Three Phase Transformers

Auto-transformers: Constructional details, copper saving, VA rating, conversion of two winding transformer to an autotransformer, applications.

Three phase transformers: Construction, principle of operation, three phase transformer connections - Y/Y, Y/Δ, Δ /Y, Δ/Δ, Open Δ and Scott connections.

Tap changing transformers

12 Hours

Total: 48 Hours

Textbook (s)

1. P. S. Bimbra, "*Electrical Machinery*", Khanna Publishers, 7th Edition, Color Reprint 2014.
2. I.J. Nagrath& D.P. Kothari, "*Electric Machines*", Tata McGraw Hill, 5th Edition, 2017.
3. A.E. Fitzgerald, Charles Kingsley, JR., Stephen D. Umans, "*Electric Machinery*", Tata McGraw Hill, 6th Edition, 2017.

Reference (s)

1. Samarjit Ghosh, "*Electric Machines*", Pearson Publications, 2nd Edition, 2012.
2. J. B. Gupta, "*Theory and Performance of Electrical Machines*", S. K. Kataria& Sons Publishers, New Delhi, 14th Edition, Reprint 2013.
3. S. K. Sahdev, "*Electrical Machines*", Cambridge University Press; 1st Edition, 2017
4. P. S. Bimbra, "*Generalized Theory of Electrical Machinery*", Khanna Publishers, 6th Edition, 2015.
5. B.L. Theraja & A.K. Theraja "*A Textbook of Electrical Technology: Volume-2, AC and DC Machines*", 23rd edition, 2019.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	25	25	---
Understand	50	50	---
Apply	25	25	---
Analyze	---	---	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. State Faraday's laws of electromagnetic induction
2. Label any 4 parts of a DC machine
3. List the different types of three phase transformer connections.
4. Define armature reaction
5. List any 4 applications of transformer

Understand

1. Compare dc generator and dc motor
2. Explain the principle of operation of DC motor
3. Justify the condition for maximum efficiency for a DC machine
4. Represent e.m.f. equation of a transformer
5. Explain why transformer rating will be given in kVA but not in kW

Analyze

1. Analyze the effect of load sharing due to impedance variations between transformers during parallel operation.
2. There is an old Tram Vehicle which was not used for more than 10 years. However, due to some requirement its working is to be restored. Up on preliminary inspection by an engineer it was diagnosed that the tram employed a DC series motor for operation with mechanical gear wheel arrangement for speed control. Further, it was also found that the entire systems in the tram are intact i.e. no physical damages were identified and ideally the tram should start working. But when the engineer tried to start the tram the motor could not start.
   (i) Identify the proper reasons for the motor not starting.
   (ii) Having known the reasons why the motor is not starting, how would you bring it back to working condition.

(iii) Since, the mechanical speed control systems are inefficient, suggest a modern control system for the motor with illustrations. Justify your selection.

3. The design specification of Transformer was provided by a foreign collaborator to reputed and experienced Indian manufacturer. The subject transformer manufacturing was going on well with all quality checks and records till the Vapour Phase Drying (VPD) process. After VPD at the stage of servicing before tanking, as per scheduled check an isolation test at 10 kV between Core laminations and Core clamping structure was performed. On application of high voltage, voltage couldn't reach beyond the level of 8 KV and collapsed. On second attempt voltage collapsed only at 800 Volts. It was a rare failure, least expected by the manufacturer. Suggest the corrective actions by reviewing the above problem statement. The Construction and transformer detail are given below.

Transformer	Generator Transformer
Power	315 MVA
Voltage	24 (LV) / 420/√3 KV (HV)
Current	11666.67 A / 1299.04 A
Vector Group	YNd11
Phase	Single
Class	420 KV

(For Open Book Examination and not for semester end examination)

4. A steel plant is constructed to be operated on a DC supply. The main functional units in the plants are depicted below.
   a. Blast furnace (BF)
   b. Steel melt shop (SMS)
   c. Rolling mill

   I. To transport coal/ raw materials over conveyor belt to blast furnace (BF). The molten steel is then transferred to steel melt shop (SMS) in wagons. The conveyor belt operates at a variable load at constant speed. Suggest a suitable motor for conveyor belt system and justify your answer.

   II. The molten metal from BF which is received by wagon is lifted by electrically operated trolley (EOT) crane for superheating the molten metal to 6000°C to remove impurities and moisture. The entire working of the SMS plant is based on the operation of the EOT crane which is used to lift and tilt the ladle (bucket) containing molten metal into the heating furnace. The weight of the molten metals will be in tons and the operation must be carried out very slowly in order to avoid casualties. Suggest a suitable motor for EOT crane and justify your answer.

   III. The molten metal from SMS is then sent to continuous casting department (CCD) where it is cooled down, solidified and cut into rectangular blooms of uniform length. The blooms are then transferred to mills where they are made into different shapes for consumer use. The output products from mills are circular wires, L and I angles, rectangular sheets etc.
      a. A motor is required to compress the bloom such that the above shapes can be obtained.
      b. Another motor is required to roll the compressed bloom into required final product.
      c. Finally, a motor is used to transfer the product to the warehouse using a conveyer belt.

   Suggest suitable motors for the operations mentioned in a,b,c in the above question and justify the same. **(For Open Book Examination and not for semester end examination)**

23EE303 Electrical Circuit Analysis-II

3 0 0 3

Course Outcomes

1. Explain three phase balanced and unbalanced circuits.
2. Illustrate transient response of RLC circuits for DC and AC excitations.
3. Outline the Laplace and inverse Laplace transforms.
4. Interpret various parameters for a given two-port network.
5. Illustrate the concepts of network topology
6. Translate the given electrical system into network function

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3									3	3	2
CO2	2	1	2									3	3	1
CO3	3	2	3									3	3	2
CO4	2	1	2									3	3	1
CO5	3	3	3									3	3	3
CO6	3	2	3									3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Three Phase Circuits

Three Phase Circuits: Advantages of 3-phase system over 1-phase systems, 3-phase balanced system connections-star connection, delta connection and their comparison, Unbalanced 3-phase connections-delta connection, 3-wire star connection, 4-wire star connection, measurement of power in 3-phase circuits using 2-wattmeter method for balanced load

10 Hours

Unit II

Laplace transforms – Definition and Laplace transforms of standard functions– Shifting theorem – Transforms of derivatives and integrals, Inverse Laplace transforms and applications.

Transient Analysis- Transient response of R-L, R-C and R-L-C series circuits for DC and sinusoidal excitations – Initial conditions - Solution using differential equation and Laplace transform approach.

14 Hours

Unit III

Two-port networks

Open circuit, short circuit, transmission, Inverse transmission, hybrid and inverse hybrid parameters and their inter relations, interconnection of two port networks, T and Π representation of two-port networks.

12 Hours

Unit IV

Network Functions: Driving point impedance and admittance, Transfer impedance and admittance, current and voltage transfer ratio, Network functions of ladder and non-ladder networks, Poles and zeros of a network function

Network Topology: Terminology used in network topology, network graph and tree, basic cut-set and basic tie-set matrices for planar networks, concept of duality and dual networks.

12 Hours

Total: 48 Hours

Textbook (s)

1. W.H.Hayt, J.E.Kimmerly, and S.M.Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 8th Edition, 2012.
2. Charles K Alexander and Mathew N.O Sadiku, "Fundamentals of Electric Circuits", Tata McGraw Hill, 5th Edition, 2013.
3. Ramana Pilla, "Network Analysis and Synthesis", Universities Press India Pvt. Ltd, 1st Edition, 2018.

Reference (s)

1. M.E Van Valkenburg, "Network Analysis", Prentice Hall of India, 3rd Edition, 2005.

2. Abhijit Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co., 6th Edition, 2014.
3. M Nahvi, Joseph Edminister, K Uma Rao, "Electric Circuits, (Schaum's Outline Series)", McGraw Hill Higher Education, 7th Edition, 2017.
4.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment Test (%)
Remember	25	25	---
Understand	50	25	---
Apply	25	50	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

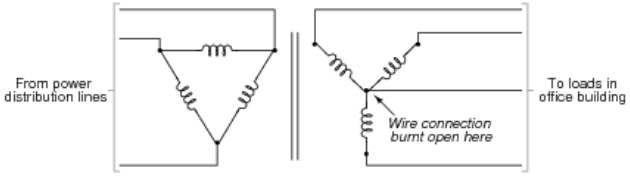
1. Why the Z-parameters are known as open circuit parameters?
2. Define time constant of RL series circuit

Understand

1. Represent transient response of RC circuit for DC excitation
2. Explain interrelation between Z and ABCD parameters.
3. Represent transient response of RL circuit for DC excitation

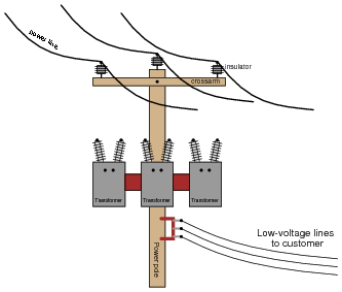
Apply

1. Develop the circuit to have underdamped response with DC excitation to the RLC series circuit.
2. Find the equivalent voltage with internal impedance when four generators with internal impedance connected in parallel. If one of the generators is fail to generate the voltage then find change in the equivalent voltage with internal impedance. **(For Open Book Examination and not for semester end examination)**
3. One of the conductors connecting the secondary of a three-phase power distribution transformer to a large office building fails open. Upon inspection, the source of the failure is obvious: the wire overheated at a point of contact with a terminal block, until it physically separated from the terminal.



What is strange, though, is that the overheated wire is the neutral conductor, not any one of the "line" conductors. Based on this observation, what do you think caused the failure?
After repairing the wire, what would you do to verify the cause of the failure? **(For Open Book Examination and not for semester end examination)**

4. An electrical lineman is connecting three single-phase transformers in a Y(primary)-Y(secondary) configuration, for power service to a business. Draw the connecting wires necessary between the transformer windings, and between the transformer terminals and the lines



Note: fuses have been omitted from this illustration, for simplicity. **(For Open Book Examination and not for semester end examination)**

23EE304 Electromagnetic Field Theory

3 0 0 3

Course Outcomes

1. Outline the concepts of vector calculus and coordinate systems
2. Summarize the laws of static electric fields
3. Examine the variations in field quantities for a given scenario in static electric fields
4. Summarize the field quantities in steady magnetic field
5. Examine the variations in field quantities for a given scenario in magnetic field
6. Summarize the Maxwell's equations in static and time varying fields

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2									3	2	1
CO2	2	1	2									3	2	1
CO3	3	3	3									3	3	3
CO4	2	1	2									3	2	1
CO5	3	3	3									3	3	3
CO6	2	1	2									3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to coordinate systems and fields

Cartesian coordinates, Cylindrical coordinates, Spherical coordinates and their relationship, Electrostatic fields, Coulomb's law and field intensity, Differential length, area and volume, line, surface and volume integrals, Electric field due to charge distribution, Electric flux density, Electric Potential.

Electric field due to discrete charge distribution

12 Hours

Unit II

Electrostatics

Gauss' Law and it's applications, del operator, gradient of a scalar, Electric dipole and flux lines, Behavior of conductors, convection and conduction currents, polarization in dielectrics, dielectric constants, continuity equation and relaxation time, Ohm's law in point form, Electrostatic boundary conditions, capacitance, energy stored in capacitors, energy density in electrostatic fields, Poisson's and Laplace's equations, general procedures for solving Poisson's or Laplace's equations, Maxwell's equation in static electric field.

Properties of materials in electric field

12Hours

Unit III

Magnetostatics

Magneto-static fields, Biot-Savart's Law and it's applications, Curl of a vector, Ampere's circuit law, application of Ampere's law, Stoke's theorem, magnetic flux density, scalar and vector magnetic potentials, Forces due to magnetic field, Lorentz's force equation, magnetic dipole, magnetic torque and moment, magnetization in materials, magnetic boundary conditions, inductors and inductances, magnetic energy. Maxwell's equation in steady magnetic field

Properties of materials in magnetic field

12 Hours

Unit IV

Time-Varying Electromagnetic Fields

Magnetic Circuits-Basic terminology, Faraday's Law, Concept of self and mutual inductance, dot convention, co-efficient of coupling, analysis of series and parallel magnetic circuits, transformer and motional electromotive forces, displacement current, Maxwell's equation in point and integral forms for time varying fields.

Modified Maxwell's equation.

12 Hours
Total: 48 Hours

Textbook (s)

1. Matthew N. O. Sadiku, "*Elements of Electromagnetics*", Oxford University Press, 7th Edition, 2018.
2. W. H. Hayt and J. A. Buck, "*Electromagnetic Field Theory*", Tata McGraw Hill, 8th Edition, 2011.
3. K A Gangadhar, "*Electromagnetic Field Theory*", Khanna Publishers, 16th Edition, 2015.

Reference (s)

1. J.D.Krauss and Daniel Fleisch, "*Electromagnetics with applications*", Tata McGraw Hill, 5th Edition, 2017.
2. Joseph A. Edminister, "*Theory and Problems of Electromagnetics*", Schaum's outline series, 4th Edition, 2013.
3. Roald K. Wangsness, "*Electromagnetic Fields*", John Wiley & Sons, 2nd Edition, 1986.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	25	25	---
Understand	50	50	---
Apply	---	---	---
Analyze	25	25	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

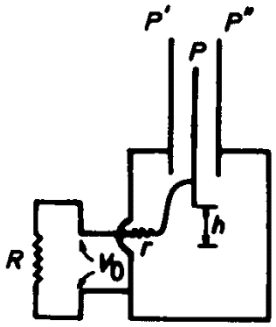
1. Reproduce the equivalent of a point in cylindrical form
2. Reproduce the equivalent of a point in spherical form
3. Label a vector in spherical form
4. Define Divergence, Gradient and Curl

Understand

1. Explain Coulomb's Law
2. Interpret Gauss' Law
3. Explain Biot-Savart's Law
4. Formulate magnetic field intensity due to long solenoid

Analyze

1. A long wire of radius R has static electric charge λ C/m placed inside a smoke precipitator. Identify the force of attraction between this wire and an uncharged spherical dielectric smoke particle of dielectric constant ϵ and radius a just before the particle touches the wire (a < R).
2. Flat metallic plates P, P^{I}, P^{II} are vertical and the plate P of mass M is free to move vertically between P^{I} and P^{II} as shown in figure below. The three plates from a double parallel plate capacitor. Let the charge on this capacitor to be Q. Ignore all the fringing filed effects. Assume that this capacitor is discharging through an external load resistor R, and neglect the small internal resistance. Assume that the discharge is slow enough so that the system is in static equilibrium at all times.



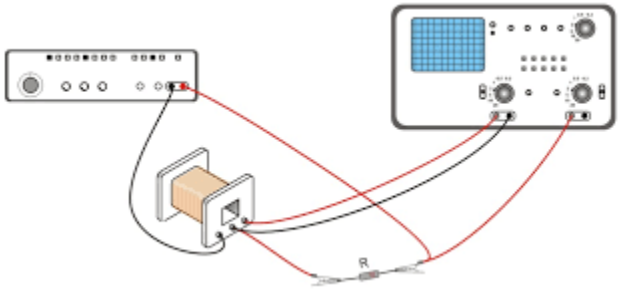
i. Assess the gravitational energy of the system that depends on the height of P.
ii. Assess the electro static energy of the system that depends on h and on the charge Q.
iii. Identify the value of h as a function of Q
iv. Analyze the output voltage whether it increase, decrease or stay the same as the given capacitor discharges.

3. A long transmission line with radius R and separation between the lines d. The potential difference V across the lines varies as $V= V_0$ Sin wt. Assume that the electric field between the plates is uniform and neglect the edge effects and radiation.

i. Analyze the direction and magnitude of the magnetic induction B at point P which is at a distance r from the axis of the capacitor.
ii. Identify the magnetic field at the point P using a piece of wire and sensitive high impedance oscilloscope. Make a sketch of your experimental arrangement and estimate the signal detected by the oscilloscope.

(For Open Book Examination and not for semester end examination)

4. The experimental set up in a transmitter station is described as follows



The various components that are used to develop the experimental set up are
a. Frequency counter.
b. Function generator.
c. Digital multimeter.
d. Analogmultimeter.
e. Voltage transformers 125/220 (two).
f. Field coil 485 turns/meter, 750 mm long.
g. Induction coil, 300 turns, 41 mm diameter.

i. Analyse the experimental and the theoretical relations between the induced voltage and current, number of turns, coil diameter and frequency.
ii. From your experimental curves, Identify the induced voltage for the case where N=350, a= 15 mm, I1= 10mA and f=10 kHz.

(For Open Book Examination and not for semester end examination)

23EE305 Measurements and Instrumentation

3 0 0 3

Course Outcomes

1. Outline the construction and working of instruments used for voltage/current measurement
2. Summarize the construction and working of instruments used for power and energy measurement
3. Analyze the performance of measuring instruments
4. Illustrate the working of AC and DC bridges
5. Explain the operation of sensors and transducers
6. Apply sensors and transducers for various applications

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2			2	3					3	2	1
CO2	2	1	2			2	3					3	2	1
CO3	3	3	3			3	3					3	3	3
CO4	2	1	2			2	3					3	2	1
CO5	2	1	2			2	3					3	2	1
CO6	3	2	2			3	3					3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Measuring Instruments

Classification of measuring instruments, different torques in an instrument, ammeters and voltmeters – PMMC, moving iron type instruments – expression for the deflecting torque and control torque – errors and compensations, extension of instrument range using shunts and multipliers, CT and PT – ratio and phase angle errors

Electrostatic voltmeter

12 Hours

Unit II

Measurement of Power and Energy

Single phase dynamometer wattmeter, LPF wattmeter, expression for deflecting and control torques, measurement of 3-phase power, single phase induction type energy meter – driving and braking torques – errors and compensations, testing by phantom loading.

Three phase energy meters

12 Hours

Unit III

Potentiometer and Bridges

Principle and operation of DC Crompton's potentiometer – standardization – measurement of unknown resistance, current, voltage – applications, methods of measuring low, medium and high resistance –Wheat stone's bridge, Kelvin's double bridge, Loss of charge method, Measurement of inductance - Maxwell's bridge, Hay's bridge, Measurement of capacitance – Desauty bridge – Schering Bridge.

Sensitivity of Wheat stone's bridge, Megger

13 Hours

Unit IV

Sensors and Transducers

Sensors and their classifications – Hall effect – Ultrasonic – Heat Flux – Fluid level measurement,

Classification of transducers – Resistive, Capacitive and Inductive transducers- active and passive transducers – strain gauges, LVDT, thermocouple.

RVDT, RTD

11 Hours

Total: 48 Hours

Textbook (s)

1. E.W. Golding, and F.C. Widdis, "*Electrical Measurements and Measuring Instruments*", Reem Publications Pvt. Ltd.,6th Edition, 2019.
2. A.K. Sawhney, "*Electrical & Electronic Measurements & Instrumentation*", Dhanpat Rai& Co. Pvt. Ltd., 19th Edition, 2015.

3. D.V.S. Murthy, "*Transducers and Instrumentation*", Prentice Hall of India, 2nd edition, 2008.
4. D.Patranabis, "*Sensors and Transducers*", Prentice Hall of India Learning, 2nd Edition, 2009.

Reference (s)

1. A. D. Helfrick and W. D. Cooper, "*Modern Electronic Instrumentation and Measurement Techniques*", Prentice Hall of India, 5th Edition, 2002.
2. H. S. Kalsi, "*Electronic Instrumentation*", Tata McGraw Hill, 4th Edition, 2009.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	25	25	---
Understand	50	50	---
Apply	---	25	50
Analyze	25	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. List the different torques in measuring instruments.
2. Label the parts of a PMMC instrument.
3. Spell down the balancing equation for AC bridge.
4. List the application of DC Crompton's potentiometer.

Understand

1. Explain the construction and operation of PMMC and moving iron instruments.
2. Justify how CT is used for current measurement.
3. Explain the concept of Schering bridge to measure unknown capacitance with neat sketch.
4. Infer the conversion of linear displacement into electrical signal in LVDT.

Apply

1. Compute the ciruit of Kelvin double bridge used for measurement of low resistance and derive the conditions for balance.
2. Demonstrate the applications of various types of strain gauges.
3. Develop the torque equation for a PMMC instrument and show its scale is linear.
4. Design a hybrid digital measuring device to measure AC/DC electrical parameters to display magnitude and type (AC/DC) on the screen of the instrument. **(For Open Book Examination and not for semester end examination)**
5. Design an automation system for a water tank using appropriate measuring and sensing instruments such that,
   a) When the tank is 75% full, an alarm should beep.
   b) When the tank is 90% full, power supply to the motor should be cut-off.
   c) When the water level is below 25%, the power supply should be on.

   Assume that the motor rating is 1.5 HP, 230 V, single phase induction motor, and other required data's may be assumed on your own. **(For Open Book Examination and not for semester end examination)**

Analyze

1. Analyze the effect of temperature on the performance of PMMC meter with and without swamping resistance.
2. Compare the PMMC and MI instruments and analyze their performance with swapping of their input supply.
3. Analyze the constructional differences between LPF and UPF wattmeter, and examine the performance of UPF wattmeter when is connected in inductive load circuit.
4. Four students had taken a house for rent. After completion of 4th semester, they went for summer internship. Before leaving the house, they have noted down the energy meter reading as 181 units. After completion of summer internship, they have come back to their rented house. Now they have

again noted down the reading, the energy meter was showing 20 units of energy consumption, literally they have not consumed any power during the period in that house. Now explain the reason behind the 20 units of energy consumption and state the remedies for this cause.

5. A group house consists of 2 floors each having 4 flats. The loads in each flat are as follows.

S. No	Electrical load	Power (W)	Time Duration (Hrs)/Day
1	Incandescent Lamp	60	6
2	Night Bulb	10	4
3	Fan	100	8
4	A/C	1500	4
5	Washing Machine	1000	2
6	Fridge	250	8
7	Geyser	4000	1

Find the total energy consumed by each flat for the above load and time duration specified if the tariff is Rs.2.50/kWh. Also suggest few measures to be taken up for energy saving. **(For Open Book Examination and not for semester end examination)**

6. Assume that 21 SWG copper conductor of 1.5 m length is provided for the testing. What will be the resistance of the copper conductor, and what will be the measuring method to find the unknown resistance of the conductor? If the conductor is wounded on,
   a) Ferro magnetic material (Assume the material is steel)
   b) Ferrite material

   What will be the inductance of the coil? And, also find the capacitance between the turns of the coil. Assume the required data for the calculations. **(For Open Book Examination and not for semester end examination)**

23EE306 Semiconductor Devices and Circuits

3 0 2 4

Course Outcomes

1. Illustrate the fundamental concepts of semiconductors and analyze the characteristics of a PN junction diode.
2. Apply knowledge of diodes and transistors to practical applications, such as clipping and clamping circuits, and rectifiers.
3. Understand biasing techniques, stabilization and compensation techniques of BJT
4. Explain the principles and operation of FETs and MOSFETs and design their biasing circuits
5. Illustrate the generalized analysis of transistor amplifier models using h-parameters.
6. Design single-stage small signal amplifiers for BJT and FET configurations.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2		3					3	2	1
CO2	2	1	2	1	2		3					3	2	1
CO3	3	2	3	2	3		3					3	3	2
CO4	2	1	2	1	2		3					3	2	1
CO5	2	1	2	1	2		3					3	2	1
CO6	2	1	2	1	2		3					3	2	1

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I **12+8 Hours**

PN Junction Devices

Introduction to Semiconductors, Energy band diagrams; PN junction diode– Effect of temperature on the diode characteristics, Diode current equation, diffusion and transition capacitance; Clipping Circuits – one level and two-level Clippers; Clamping Circuits – Working of Clamping Circuit, Practical Clamping Circuit, Biased Clamping Circuits, Clamping Circuit Theorem - Tunnel Diode characteristics.

LED and Photo diodes

Practical Component

1. PN Junction diode characteristics
2. Zener diode characteristics
3. Full wave center tapped rectifier with and without filter.
4. Bridge type Full wave rectifier

12+8 Hours

Unit II

Bipolar Junction Transistor

BJT- construction, types, operation, current components, CE, CB and CC configurations, BJT as an amplifier, BJT biasing - Criteria for fixing operating point, Fixed bias, Collector to base bias, self-bias, stabilization techniques, Compensation techniques- compensation against variation in V_{BE} and I_{co}, thermal run away, thermal stability.

Unijunction transistor

Practical Component

1. Transistor CE characteristics (Input and Output)
2. Transistor CB characteristics (Input and Output)
3. Design of fixed bias circuit
4. Design of self-bias circuit

12+8 Hours

Unit III

Field Effect Transistor

FET – types, construction, operation and characteristics – JFET parameters, FET as an amplifier, FET biasing – Fixed bias circuit, voltage divider bias circuit, self-bias circuit, MOSFET- types, construction operation and characteristics – MOSFET biasing

FET as a Voltage Variable Resistor, Zener barrier

Practical Component

1. JFET characteristics
2. MOSFET characteristics
3. Fixed bias circuit
4. Voltage divider bias circuit

12+8 Hours

Unit IV

Amplifiers

Generalized analysis of transistor amplifier model using h-parameters, Approximate analysis of CE, CC and CB configuration, Single stage amplifiers – CE, CC and CB amplifiers, small signal analysis of single stage BJT amplifiers – CE amplifier with fixed bias, CE amplifier - emitter resistor, Un-bypassed emitter resistor, voltage divider bias-generalized analysis of FET small signal model.

Analysis of CS and CD amplifiers

Practical Component

1. Characteristics of CE Amplifier
2. Characteristics of CS Amplifier
3. Frequency response of CE amplifier
4. Frequency response of CS amplifier

11+7 Hours

Total: 48 + 32=80 Hours

Textbook (s)

1. A.Salivahanan and N.Suresh Kumar, *Electronic Devices and Circuits*, McGraw-Hill Education (India) Private Limited, 1st Edition, 2018.
2. J.Millman, C.C.Halkias and Chetan D Parikh, *Integrated Electronics*, 2nd Edition, Tata McGraw Hill, 2017
3. Robert L. Boylestad and Louis Nashelsky, *Electronic Devices and Circuits Theory*, Pearson/Prentice Hall, 11th Edition, 2015.

Reference (s)

1. Visvesvara Rao, K. Bhaskara Rama Murty, K. Raja Rajeswari, P.Chalam Raju Pantulu, *Electronic Devices and Circuits*, Pearson Education, 2nd Edition, 2007.
2. S.G.Burns and P.R.Bond, *Principles of Electronic Circuits*, Galgotia Publications, 2nd Edition, 2008.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	20	20
Understand	55	55
Apply	25	25
Analyze	--	--
Evaluate	--	--
Create	--	--
Total (%)	100	100

Sample Question (s)

Remember

1. List any two advantages of JFET over BJT.
2. What is rectifier?
3. What are the salient features of h parameters?
4. Draw the symbol of diode, zener diode and JFET

Understand

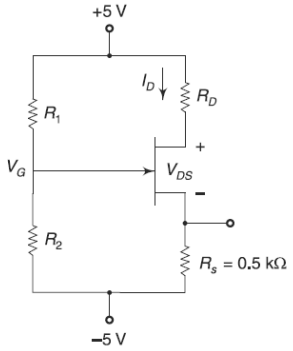
1. Derive the relationship between α and β of BJT.
2. Explain the construction and operation of n-channel JFET.
3. Explain about JFET fixed bias and collector to base bias circuits with neat sketch.
4. Describe the construction and operation of depletion and enhancement type MOSFET.

Apply

1. In a transistor circuit, collector load is 4 kΩ whereas quiescent current (zero signal collector current) is 1mA. (i) What is the operating point if VCC = 10 V? (ii) What will be the operating point if RC = 5 kΩ?
2. A CE amplifier is driven by a voltage source of internal resistance Rs = 800, and the load impedance is

a resistance R_L = 1000 Ω. The h-parameters are h_{ie} = 1 k Ω, h_{re} = 2 × 10 – 4, h_{fe} = 50 and h_{oe} = 25 μA/V. Compute the current gain A_I, input resistance R_i, voltage again A_V and output resistance R_o using exact analysis and using approximate analysis.

3. A voltage divider bias is provided to an N-channel JFET circuit as shown in Fig. To establish I_{DSS} = 10 mA, V_P = –3.5 V, R_1 + R_2 = 120 kW, I_D = 5 mA and V_{DS} = 5 V, determine the values of R_1, R_2 and R_D.



23EE307 DC Machines Lab

0 0 3 1.5

Course Outcomes

1. Illustrate the procedure for representing magnetization characteristics of DC shunt generator.
2. Interpret the efficiency of DC machine using various tests.
3. Demonstrate suitable method to find the performance characteristics of DC machine.
4. Interpret various losses of DC machine by performing indirect tests.
5. Demonstrate suitable method to find the stray losses of a DC machine.
6. Illustrate the procedure for implementing speed control methods for DC motors.

COs –POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2		3		2			3	2	1
CO2	3	2	3	2	3		3		3			3	3	2
CO3	3	2	3	2	3		3		3			3	3	2
CO4	3	2	3	2	3		3		3			3	3	2
CO5	3	2	3	2	3		3		3			3	3	2
CO6	2	1	2	1	2		3		2			3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. Magnetization characteristics of DC shunt generator
2. Internal characteristics of DC shunt generator
3. External characteristics of DC shunt generator
4. Load test on DC series generator
5. Internal characteristics on DC compound generator
6. External characteristics on DC compound generator
7. Hopkinson's test on DC shunt machines
8. Swinburne's test
9. Speed control of DC shunt motor by controlling the armature current
10. Speed control of DC shunt motor by controlling the Field current
11. Brake test on DC shunt motor
12. Separation of losses in DC shunt motor
13. Brake test on DC compound motor
14. Brake test on DC series motor
15. Field test on DC Series Machines
16. Retardation test on DC Shunt Motor

List of Augmented Experiments[1]

1. Simulation of brake Test on a DC shunt motor
2. Simulation of Swinburne's test
3. Simulation of separation of losses in A DC shunt motor
4. Simulation of open circuit characteristics of a DC shunt generator
5. Simulation of speed control of a DC shunt motor

Reading Material (s)

1. P. S. Bimbra, "*Electrical Machinery*", Khanna Publishers, 7th Edition, Color Reprint 2014.
2. I.J. Nagrath& D.P. Kothari, "*Electric Machines*", Tata McGraw Hill, 5th Edition, 2017.
3. S. K. Sahdev, "*Electrical Machines*", Cambridge University Press, 1st Edition, 2017

[1] Students shall opt any one of the augmented experiments in addition to the regular experiments

23EE308 Python Programming Lab

0 0 3 1.5

Course Outcomes

1. Understand the available programming platforms for problem solving using python.
2. Apply mathematical and logical methods which improve critical thinking.
3. Understand and apply python programs with constraints and iterative statements
4. Develop python programs step-wise by defining functions and calling them.
5. Apply python lists, tuples and dictionaries for representing compound data.
6. Analyze various searching and sorting techniques using python and apply exception handling.

COs –POs Mapping

COs	PO_4
1	3
2	3
3	3
4	3
5	3
6	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. (a)Installation of Python and setting up environmental variables.
   (b)Write a Python program to perform the following operations on two integers a and b
   (i)Arithmetic operations (ii) Logical operations
   (c)Write a python Program to find the ASCII value of a Character and vice versa (use ord and chr methods).
   (d)Write a python Program to convert a given decimal number into binary, octal and hexadecimal (use bin, oct and hex methods).
2. (a) Write a Python program to check the given year is a leap year or not using if statement.
   (b) Write a Python Program to perform following operations on List
   (i)Create an Empty list (ii) Append the elements into list (iii)Find the length, minimum, maximum.
3. (a)Write a Python program to use python generators to print all the prime numbers upto the given value 'n'.
   (b) Write a Python program for a given list of numbers print all the numbers one by one-using iterators in python.
4. (a)Write a Python program to flatten a nested list.
   (b)Write a Python program to find the transpose of the matrix using list.
5. Write a Python program in a given list of numbers create another list of even numbers using list comprehension.
6. Write a Python Program to remove punctuations from a string.
7. (a)Write a Python program to find the cube of a given number using lambda()/anonymous function.
   (b)Write a Python program to filter only even numbers from a given list using filter method.
8. (a)Write a Python program to find the squares of the list of numbers using map function.
   (b)Write a Python program to print all the combinations for the given list of numbers using itertools.
9. Define a class and write a method which accepts multiple parameters/arguments and find the sum of given parameters.
10. Write a Python program to search a key element in the list using linear search approach.
11. Write a python program to Convert the given list to numpy array.
12. Write a Python program Create a pandas data frame with two dimensional list.
13. Write a Python program to Create a data frame from dict of numpy array.

List of Augmented Experiments[2]

1. Read n strings as input and print the frequency of characters in all the string but keep the below cases inmind

[2] Students shall opt any one of the augmented experiments in addition to the regular experiments

   a. If string contains any digit raise user defined exception “string has digit in it”
   b. If string contains any space raise user defined exception “string has space in it”
   c. If string contains any special characters raise a user defined exception “string contains specialcharacters”
2. Implementation of Selection Sort using Python.
3. Implementation of Insertion Sort using Python.
4. Develop a gaming application Tic Tac Toe.
5. Develop a gaming application Chess.
6. Develop an editor in Python.
7. Develop a program to test the typing speed using Python.
8. Develop a program for Number Guessing.
9. Develop Website using Python.
10. Develop a Game Spin a Yan.
11. Develop a Phone Book using Python.
12. Develop Python Story /Paragraph Generator using Keywords entered(min 10 keywords to be entered)

Reading Material (s)

1. Fundamentals of Python Programming ,Richard L. Halterman 2019
2. Kenneth A. Lambert. “Fundamentals of Python: First Programs”, 2nd Edition, Publisher: Cengage Learning 2018
3. Python Programming: A Modern Approach, VamsiKurama, Pearson 2017.
4. Python Programming Lab manual – Department of EEE-GMRIT, Rajam.

23ESX01 Employability Skills I

0 0 2 0

Course Outcomes

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1	1	1	1			2	3		3	1	
CO2	1		1	1	1	1			2	3		3	1	
CO3	1		1	1	1	1			2	2		3	1	
CO4	2		2	2	2	2			3	1		3	1	
CO5	3		2	2	2	2			3	1		3	2	
CO6	2		2	2	3	3			3	1		3	3	

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

PART-A

Soft Skills

Communication Skills & Confidence: How Communication Skills affect Confidence? How to communicate Effectively. (with Examples)

Listening: Listening? , Listening Vs Hearing, Possible reasons for why people do not Listen at times, Active Listening Vs Passive Listening, How Listening can affect our relationships? How Listening helps in Campus Placements also? (with Examples)

Goal Setting: SMART Technique to Goal Setting, Putting First things First, SWOT Analysis and Time Management

Attitude & Gratitude: Attitude Vs Skills Vs Knowledge, Attitude Vs Behavior, How to develop Positive Attitude? Developing the attitude of Gratitude.

Public Speaking: JAM, J2M, Presentations by Students on General Topics.

7 Hours

PART-B

Aptitude Skills

Quantitative Aptitude:

Number system, L.C.M and H.C.F, Problems on Ages, Averages, Time and work, Pipes and cisterns

8 Hours

PART-C

Domain Specific Knowledge

Programmable logic controllers -1

a) Implementation of basic logic gates
b) Implementation of simple relay
c) Implementation of direct on-line starter
d) Implementation of on and off delay timer
e) Implementation of series and parallel switches

15 Hours

Total: 30 Hours

Text Book (s)

1. Frederick D. Hackworth and John R. Hackworth, *Programmable Logic Controllers: Programming Methods and Applications*, Pearson India; 1st edition, 2003.
2. Frank Petruzella, *Programmable Logic Controllers*, Tata McGrawhill, 3rd Edition, 2011.

Reference (s)

1. Gary Dunning, Thomson Delmar, "*Programmable Logic Controller*", Cengage Learning, 3rd Edition, 2005.
2. W. Bolton, "*Programmable Logic Controllers*", Newnes – Elsevier, 2015.

23EE401 AC Machines

3 0 0 3

Course Outcomes

1. Illustrate the constructional features and working of induction motor
2. Analyze the performance of induction motor
3. Outline the various starting, speed control and testing methods of induction motors
4. Illustrate the constructional features and working of synchronous machine
5. Outline the regulation methods of an alternator
6. Analyze the performance of synchronous machine

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2				3					3	2	1
CO2	3	3	3				3					3	3	3
CO3	2	2	2				3					3	2	2
CO4	2	1	2				3					3	2	1
CO5	2	2	2				3					3	2	2
CO6	3	3	3				3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Three-phase Induction Machines

Three-phase induction motors-constructional details of cage and wound rotor machines-production of rotating magnetic field - principle of operation, rotor e.m.f and rotor frequency, rotor reactance, rotor current and p.f at standstill and during operation, torque equation- expressions for maximum torque and starting torque, torque-slip characteristics, equivalent circuit, power stages, circle diagram, Applications

Crawling and cogging

12 Hours

Unit II

Speed Control and Starting Methods

Speed control-change of frequency, pole changing methods, rotor resistance control and cascade connection, voltage injection into rotor circuit, starting methods.

Single phase Induction motors: principle of operation, Double revolving field theory, equivalent circuit, Starting methods and applications.

Universal motor and BLDC motor.

12 Hours

Unit III

Synchronous Generators

Constructional features of wound rotor and salient pole machines – Armature windings –Distribution, pitch and winding factors, E.M.F equation, harmonics in generated e.m.f. – suppression of harmonics, armature reaction, phasor diagram, Regulation by synchronous impedance method, M.M.F. method, Z.P.F. method- two reaction theory-determination of X_d and X_q (slip test), phasor diagram, regulation of salient pole alternator.

Synchronization of alternators with infinite bus, Parallel operation - Effect of change in excitation and mechanical power input

Synchronizing power and torque, Applications of Synchronous Generators

12 Hours

Unit IV

Synchronous Motors

Principle of operation, Phasor diagram, methods of starting, variation of current and power factor with excitation, losses and efficiency, synchronous condenser, power factor improvement, hunting and its suppression, Applications

Excitation circle and power circle, comparison of synchronous and induction motors.

12 Hours

Total: 48 Hours

Textbook(s)

1. P. S. Bimbra, "*Electrical Machinery*", Khanna Publishers, 7th Edition, Color Reprint 2014.
2. I.J. Nagrath& D.P. Kothari, "*Electric Machines*", Tata McGraw Hill, 5th Edition, 2017.
3. A.E. Fitzgerald, Charles Kingsley, JR., Stephen D. Umans, "*Electric Machinery*", Tata McGraw Hill, 6th Edition, 2017.

Reference (s)

1. M. G. Say, "*The Performance and Design of Alternating Current Machines*", CBS Publishers and Distributers Pvt. Ltd., 3rd edition, 2005.
2. Samarjit Ghosh, "*Electric Machines", Pearson Publications*, 2nd Edition, 2012.
3. J. B. Gupta, "*Theory and Performance of Electrical Machines*", S. K. Kataria & Sons Publishers, New Delhi, 14th Edition, Reprint 2013.
4. S. K. Sahdev, "*Electrical Machines*", Cambridge University Press; 1st Edition, 2017
5. P. S. Bimbra, "*Generalized Theory of Electrical Machinery*", Khanna Publishers, 6th Edition, 2015.
6. B.L. Theraja & A.K. Theraja "*A Textbook of Electrical Technology: Volume-2, AC and DC Machines*", 23rd edition, 2019.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	25	25	---
Understand	50	50	---
Apply	25	25	---
Analyze	---	---	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define cogging and crawling
2. Find difference between ac and dc generator?
3. Define Potier reactance
4. List the starting methods of synchronous motor

Understand

1. Explain why the rotor of induction motor can never attain synchronous speed.
2. Prove the condition $P_2:P_m: P_c=1:(1-s):s$ for an induction motor.
3. Show the generalized expression for an induced emf per phase in three phase alternators when coils are not full pitch and concentrated in one slot.
4. Identify the equivalent circuit parameters of 3-phase induction motor from the no-load and blocked rotor tests

Analyze

1. Three alternators having its voltages and impedances E_1& Z_1, E_2 & Z_2, E_3 & Z_3 respectively are connected in parallel to share a load. Derive the expressions I_1, I_2 and I_3 for load sharing of alternators.
2. Draw the circle diagram for a 5.6kw, 400V, 3-Φ, 4-pole, 50Hz, slip ring u=induction motor from the following data.

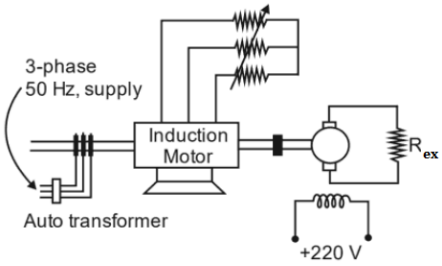
   No- load readings: 400V, 6A, $\cos\Phi_0=0.087$, Short circuit test data: 100V,12A,720W.

   The ratio of primary to secondary turns=2.62, Stator resistance per phase is 0.67Ω and of the rotor is 0.185Ω. Calculate
3. An Industry has the following loads and are connected to supply of three phase 400V,50Hz.

Induction motor 1: 2.5kW, Z= 2.5+3j Ω
Induction motor 2: 3.6kW, Z= 1.6+2.5j Ω
Induction motor 3: 4.5kW, Z= 1.8+4.3j Ω
Induction motor 4: 5.3kW, Z= 2.1+1.8j Ω
Lighting load : 10kW, Z=6+4jΩ.

Design the suitable synchronous condenser to raise the industry power factor to 0.9 p.f lagging. **(For Open Book Examination and not for semester end examination)**

4. A 3-phase, 440 V, 50 Hz, 4-pole slip ring induction motor is feed from the rotor side through an auto-transformer and the stator is connected to a variable resistance as shown in the figure



The motor is coupled to a 220 V, separately excited d.c generator feeding power to fixed resistance of 10 W. Two-wattmeter method is used to measure the input power to induction motor. The variable resistance is adjusted such that the motor runs at 1410 rpm and the following readings were recorded W1 = 1800 W, W2 =- 200 W.

(i) Find the speed of rotation of stator magnetic field with respect to rotor structure
(ii) Neglecting all losses of both the machines, the dc generator power output and the current through resistance R_{ex} **(For Open Book Examination and not for semester end examination)**

5. A colony having 25 houses and each house has a load of 5kw, and an average p.f is 0.85lag. All the loads has connected to a transformer of 150 VA, 440/230V. An additional apartment was constructed newly and it has the load of 50kW. Estimate the necessity of upgrading the existing transformer or a new transformer is required separately to the apartment. If so, what is the new rating of the transformer, and comment on efficiency of the transformer. **(For Open Book Examination and not for semester end examination)**

23EE402 Linear and Digital Integrated Circuits

3 0 2 4

Course Outcomes

1. Infer the DC and AC characteristics of operational amplifiers and its effect on output
2. Elucidate and Design the linear applications of an Op-Amp
3. Elucidate and Design the non-linear applications of an Op-Amp
4. Identify a suitable tool (Boolean theorems, K-maps, Tabular etc.) to minimize Boolean expressions
5. Design and implement the combinational logic circuits
6. Design and implement the sequential logic circuits

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	1				1				1	1
CO2	3	2	3	2	3				3				3	2
CO3	3	2	3	2	3				3				3	2
CO4	2	1	2	1	2				2				2	1
CO5	3	2	3	2	3				3				3	2
CO6	3	2	3	2	3				3				3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit-I

Op-Amp and characteristics

Introduction to Op-Amp, Ideal Op-Amp characteristics, DC characteristics, AC characteristics, Voltage -series feedback and voltage -shunt feedback, Frequency response of Op-Amp - Basic applications: inverting, noninverting and differential amplifier circuits, Adder-subtractor circuits, Differentiation and integrator circuits

Precision rectifiers

Practical Component

1. Voltage gain of non-inverting and inverting amplifier with feedback
2. OP AMP Applications–Adder and Subtractor.
3. Differentiator
4. Integrator

12+8 Hours

Unit II

Application of Op-Amps

Instrumentation amplifiers, First-order and Second order active filters, V to I and I to V converters, Comparators and Astable multi-vibrators, Triangular waveform generator, Clippers and Clampers, Peak detector, Weighted resistor type and R-2R ladder type D/A converters, Flash type A/D converter.

Schmitt Trigger

Practical Component

1. Active Filters–LPF, HPF (first order only)
2. Triangular wave Generator using 741OP AMP
3. Analog to Digital Converter using OP AMP
4. Digital to Analog Converter using OP AMP

12+8 Hours

Unit III

Boolean function minimization and combinational logic circuits

Review of Number System, Minimization of Boolean functions up to four variables using Karnaugh Map - PoS and SoP, with don't care conditions, Minimization of Boolean functions using tabular method, Combinational logic circuits - half adder, full adder, half-subtractor, full-subtractor, comparator, encoder, priority encoder, decoder, multiplexer, de-multiplexer, realization of switching functions using combinational logic circuits.

Code converters

Practical Component

1. Half adder and full adder
2. Half subtractor and full subtractor
3. 4X1 multiplexer and 1X4 demultiplexer

4. 8X3 encoder and 3X8 decoder

12+8 Hours

Unit IV

Sequential Logic circuits

Introduction to flip-flops, Registers - buffer register, controlled buffer register, shift registers, bi-directional shift register, universal shift register, Asynchronous & Synchronous counters - up, down, up down, ring counters, Johnson counters, Mealy and Moore state machines - conversion, reduction of state tables and state assignment.

Sequence Generator, Sequence detector

Practical Component

1. Shift registers
2. Synchronous counter
3. Asynchronous counter
4. Johnson / Ring counter

12+8 Hours

Total: 48+ 32=80 Hours

Textbook (s)

1. R.F. Coughlin and Fredrick Driscoll, "*Operational Amplifiers & Linear Integrated Circuits*", Pearson Education, 6th Edition, 2000.
2. Ramakanth A. Gayakwad, "*Op-Amps & Linear ICs*", Pearson Education, 4th Edition, 2015.
3. Morris Mano, "*Digital Design*", 3rd Edition, PHI, 2018.
4. A. Anand Kumar, "*Switching theory and logic design*", PHI, 3rd Edition 2016.

Reference (s)

1. D. Roy Chowdhury, "*Linear Integrated Circuits*", New Age International (p) Ltd., 4th Edition, 2011.
2. Sergio Franco, "*Design with Operational Amplifiers & Analog Integrated Circuits*", McGraw-Hill Higher Education, 2003.
3. Zvi Kohavi, "*Switching & Finite Automata theory*", 2nd Edition, TMH, 2010.
4. R P Jain, "*Modern Digital Electronics*", 3rd Edition, TMH, 2009.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)
Remember	25	25
Understand	50	25
Apply	25	50
Analyze	--	--
Evaluate	--	--
Create	--	--
Total (%)	100	100

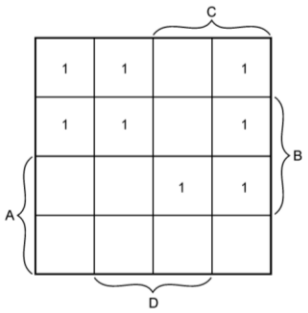
Sample Question (s)

Remember

1. List any four linear applications of op-amp.
2. List the ideal characteristics of operational amplifier
3. What is meant by the radix or base of a number system?
4. Define asynchronous sequential circuit.

Understand

1. Draw the circuit diagram of an instrumentation amplifier and explain its operation.
2. Explain the successive approximation type A/D converter.
3. What is an encoder? How does a priority encoder differ from a conventional encoder? With the help of a truth table, briefly describe the functioning of a 10-line to four-line priority encoder with active LOW inputs and outputs and priority assigned to the higher-order inputs.
4. Write the simplified Boolean expression given by the Karnaugh map shown in figure.



Apply

1. Design a practical differentiator that will eliminate the limitations of ordinary differentiator using op-amp
2. Design a 4bit binary adder using finite state machine.
3. Design a two-bit magnitude comparator. Also, write relevant Boolean expressions.
4. Implement the product-of-sums Boolean function expressed by ∏1,2,5 by a suitable multiplexer.

23EE403 Power Electronics

3 0 0 3

Course Outcomes

1. Summarize the operation of various power semiconductor devices
2. Outline the control and protection methods for power semiconductor devices
3. Analyze the performance of AC-DC for various loads
4. Examine the performance of AC-AC converters
5. Investigate the performance of DC-DC converters
6. Analyze the performance of DC-AC inverters

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2									3	2	1
CO2	2	1	2									3	2	1
CO3	3	2	3									3	3	2
CO4	3	2	3									3	3	2
CO5	3	2	3									3	3	2
CO6	3	2	3									3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Power Semiconductor Devices

Introduction to power electronics devices - Construction, operation, and characteristics of thyristor family (SCR & GTO), BJT, MOSFET, IGBT - Turn on and turn off methods of SCR - Two transistor analogy of SCR - SCR firing and protection circuits - Series and parallel operations of SCR - Introduction to wide-bandgap semiconductor devices (SiC & GaN).

Role of Gate Drive Circuits in Power Electronics

12 Hours

Unit II

Phase Controlled Converters (AC-DC Converters)

Introduction to phase-controlled converter – Operation of 2-pulse, 3-pulse, and 6-pulse converter with R, RL, and RLE loads – Derivation of average load voltage and average load current – Effect of source inductance on single-phase controlled converter – Introduction to dual converter.

Improved Power Quality AC-DC Converters

12 Hours

Unit III

AC–AC Converters

Introduction to AC-AC converter - AC voltage controllers - Operation of single-phase AC voltage regulator - Derivation of RMS load voltage and RMS load current – Cyclo-converters – Operation of single-phase to single-phase.

Three phase AC voltage controller

12 Hours

Unit IV

Choppers & Inverters

Introduction to choppers – Operation of buck, boost, and buck-boost dc-dc converters - Derivation of average load voltage and average load current - Time ratio control and current limit control strategies – Introduction to high frequency isolated dc-dc converters.

Introduction to voltage source inverters – Operation of single-phase half and full bridge inverters – Operation of three-phase inverters with 180-degree and 120-degree conduction mode - Pulse width modulation techniques (Single, Multiple, and Sinusoidal) - Introduction to current source inverters.

Introduction to Space Vector Modulation

12 Hours

Total: 48 Hours

Text Book (s)

1. M. H. Rashid, *Power Electronics: Circuits, Devices and Applications*, PHI, 2nd Edition, 2009.
2. P.S. Bhimbra, *Power Electronics, Khanna Publishers*, 4th Edition, 2012.
3. M.D. Singh & K.B. Kanchandhani, *Power Electronics*, TMH, 2nd Edition, 2008.
4. Ned Mohan, Tore M. Undeland, William P. Robbins, *Power Electronics - Converters, Applications, and Design*, Wiley Publishers, 3rd Edition, 2002.

Reference(s)

1. Robert W. Erickson, Dragan Maksimović, *Fundamental of Power Electronics*, Springer, 1ST Edition, 1997.
2. Barry W. Williams, *Power Electronic, Devices, Applications, and Passive Components*, McGraw Hill Higher Education, 2nd Edition, 1992.
3. Vedam Subramanyam, *Power Electronics*, New Age International Pvt. Limited, 1st Edition, 2015.
4. L. Umanand, *Power Electronics: Essentials & Applications*, Wiley Publishers, 1st Edition, 2009.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	20	20	---
Understand	60	50	---
Apply	---	---	---
Analyze	20	30	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define latching current & holding current
2. Define firing angle
3. List the advantages of dc-ac converters
4. What is an inverter?
5. Define duty cycle of the switch

Understand

1. Explain static V-I characteristics of an SCR
2. Explain the differences between series and parallel operation of SCRs
3. Compare the performance of the converter when it is connected with R, RL loads
4. Classify the different power converters based on input and output supply
5. Explain the operation of the single-phase ac voltage controller

Analyze

1. Analyze the performance of single-phase full converter and half–wave-controlled converters
2. Analyse the impact of source inductance on the performance of single-phase ac-dc converters
3. Assess the importance of various PWM technique in an inverter operation
4. Assume the situation that an isolated 5kW solar PV system needs to be established in agricultural field. The solar PV source of $60V_{DC}$ has to deliver the required power to drive the induction motor for the pumping application in agricultural field. In addition, it has to deliver the required power to some heating loads. Assume the heating load of 1 kW requires DC source of $300V_{DC}$, and the induction motor of 4 kW capacity requires 440 V_{AC} sources.
    i. How many power conversion stages required to attain the above-said objectives? Draw the optimal layout of the PV system and illustrate the function of each conversion stage. Justify your answer with proper reasons.
    ii. Compare and select a suitable power semiconductor switch with complete rating details for various power conversion stages.

iii. Select an optimal modulation technique to generate the gate pulse which suits for various switches in converter/inverter. Justify.

iv. During operation, assume the situation that induction motor speed increases more than synchronous speed. What are the necessary steps needs to be taken to overcome this issue? Justify with proper reasons.

(For Open Book Examination and not for semester end examination)

5. Identify a suitable power converter for a single-phase induction motor for variable speed application. Justify your answer with supportive design procedure.

(For Open Book Examination and not for semester end examination)

23EE404 Power Generation, Transmission and Distribution

3 0 0 3

Course Outcomes

1. Illustrate the working principles of various power generating stations
2. Interpret the parameters for various overhead conductor configurations.
3. Analyze the performance of short, medium and long transmission line models.
4. Develop the mechanical design parameters of transmission line.
5. Illustrate the construction and working of cables and insulators.
6. Compare the operation of AC and DC distribution systems.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2			2	3					3	2	1
CO2	2	1	2			2	3					3	2	1
CO3	3	3	3			3	3					3	3	3
CO4	3	2	3			3	3					3	3	2
CO5	2	1	2			2	3					3	2	1
CO6	3	3	3			3	3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Power Generating Stations

Hydel Power Stations- classification-construction and working of hydroelectric power station, thermal power Stations-single line diagram highlighting major components and working, nuclear power stations- nuclear fission and chain reaction-working of nuclear reactors-BWR, PWR

Breeder reactors

10 Hours

Unit II

Transmission Line parameters and performance

Transmission Line Parameters: Transmission line components, GMR and GMD, Numerical problems on resistance, inductance and capacitance for single phase and three phase single circuit symmetrical and asymmetrical configurations (no derivation), Performance of Short, Medium and Long Transmission Lines: model description with phasor diagram for Short, Nominal-T, Nominal-π and long transmission lines respectively. ABCD parameter interpretation and calculation of transmission efficiency and voltage regulation

Ferrant, Skin and Proximity effects, surge impedance loading, , Corona loss and its effects

14 Hours

Unit III

Underground cables and Mechanical design of overhead lines

Underground Cables: Construction, Types of Cables ,Calculation of Insulation resistance and stress in insulation, Capacitance of single and 3-core belted cables, Grading of cables -capacitance grading and Inter-sheath grading.

Insulators-types-calculation of string efficiency

Sag and Tension calculations with equal & unequal heights of towers- effect of wind & ice loading,

Grading of Insulators

12 Hours

Unit IV

DC & AC distribution systems

Distribution System-Components, connection schemes, classification and comparison; Voltage Drop Calculations in DC Distributors for the following cases: Radial DC Distributor fed one end and at both the ends (equal/unequal Voltages) and Ring Main Distributor.

Voltage Drop Calculations in AC Distribution System- Distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages.

and numerical problems, Tariff-Types and numerical problems

Economics-terminology, 11kV Substation layout

12 Hours

Total: 48 Hours

Textbook (s)

1. C.L. Wadhawa, "*Generation, Distribution and Utilization of Electric Energy*", New Age International (P) Limited, 4th Edition, 2017.
2. C.L. Wadhawa, "*Electric Power Systems*", New Age International (P) Limited, 7th Edition, 2017.
3. TuranGonen, *Electric Power Distribution system*, Engineering, McGraw-hill Book Company, 4th edition,2016.

Reference (s)

1. A Chakrabarti, ML Soni, PV Gupta, US Bhatnagar, "*A text book on Power System Engineering*," Dhanpat Rai & Co., 2008.
2. Hadi Saadat, *Power System Analysis*, TMH, 3rd edition, 2010.
3. VK Mehta and R Mehta, "*Principles of power system*," S. Chand, New Delhi, 4th edition, 2005.
4. S.N.Singh, "Electric Power Generation, Transmission and Distribution", PHI, 2nd edition, 2008

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	25	25	---
Understand	50	50	---
Apply	---	25	50
Analyze	25	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Illustrate the single line diagram of a power system
2. Define GMD
3. List any two effects of corona
4. Define Skin effect in the long transmission line

Understand

1. Classify hydroelectric power plants based on water flow, head, power generated and load
2. Explain any four differences between short and medium transmission line models
3. Outline the construction of an underground cable
4. Summarize any four benefits of bundle Conductors over single conductor.

Apply

1. Develop the model of a Nominal-T transmission line to transfer a power of 100MW for a distance of 80km. Assume any other parameters required.
2. A certain amount of power has to be transmitted from the generating station to a load centre passing through a densely populated urban area extending a distance of 50km. The site engineer has the choice of selecting overhead or underground cables for transmission. Help the engineer choose the type of transmission based on economy, safety and technical superiority.
3. 1000 MW of power has to be transmitted for a distance of 500km over a 400kV double circuit long transmission line. Select a suitable spacing pattern between conductors and calculate the inductance. Justify your selection.
4. Suppose you are a maintenance engineer working at load end and observe the distribution side parameters. At some instant, you observe abnormalities due to light load condition. To solve that issue you have checked with the state load dispatch centre, and figured out that the voltage at the generating station is less as compared to the voltage at your end. Make use of this information and identify the possible impacts at your end with the help of a suitable phasor diagram. Suggest remedies to overcome this situation and obtain a voltage balance in a system.

(For Open Book Examination and not for semester end examination)

Analyze

1. Compare the AC and DC distribution systems for distribution of power in an urban area
2. A certain amount of power has to be transmitted over a distance of 100km at 66kV. Develop and compare the T and Pi models and suggest which is more preferable for transmitting the power keeping in view the complexity of solving the network for parameter analysis.
3. Compare the different compounding methods and suggest which is the best method for super thermal power plants employing two stage steam turbines.
4. A cyclone named Titili with wind gusts around 170 km/hr hit the north costal region of Andhra Pradesh. Your locality was within five kilo meters from the epicentre of the cyclone. As a result, transmission lines and towers got damaged. The load end requires 100MVA load at power factor of 0.8 lagging for daily smooth operation. As an electrical engineer, design the conductor configuration based on the following:
    - choice of voltage level
    - choice of conductors
    - Type of circuits
    - spacing of the conductor

(For Open Book Examination and not for semester end examination)

23EE405 Signals and Systems Theory

3 0 0 3

Course Outcomes

1. Outline the various classifications of signals and systems.
2. Apply Fourier series to any arbitrary periodic signals.
3. Analyze the time and frequency response of any arbitrary signal using Fourier Transform.
4. Apply Laplace Transforms for a given continuous time signal.
5. Apply Z-Transforms for a given discrete time signal.
6. Analyze the relationship between Laplace and Z-Transforms.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2									3	2	1
CO2	2	1	1									3	2	1
CO3	3	2	2									3	3	2
CO4	2	1	2									3	2	1
CO5	3	3	3									3	3	3
CO6	2	1	1									3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Mathematical Description and Analysis of Signals

Definition of Signals and Systems, Classification of Signals, Classification of Systems, Operations on signals: time-shifting, time-scaling, amplitude shifting, amplitude-scaling. Complex exponential and sinusoidal signals, power and energy signals, impulse function, step function, signum function and ramp function, convolution sum , convolution integral.

Orthogonal signals

(12 Hours)

Unit II

Fourier series and Fourier transforms

Fourier series representation of continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Relation between Trigonometric and Exponential Fourier series, Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms.

Fourier transforms involving impulse function and Signum function.

(12 Hours)

Unit III

Laplace transforms

Introduction, Concept of region of convergence (ROC) for Laplace transforms, constraints on ROC for various classes of signals, Properties of L.T's, Inverse Laplace transform, Relation between L.T's, and F.T. of a signal.

Laplace transforms involving impulse function and Signum function.

(12 Hours)

Unit IV

Z-Transforms

Introduction, Concept of Z-Transform of a discrete sequence. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms. Distinction between Laplace, Fourier and Z transforms.

Sampling theorem

(12 Hours)

(Total: 48 Hours)

Textbook (s)

1. V. Oppenheim, A. S. Willsky and S. H. Nawab, *Signals and Systems*, PHI, 2nd Edition, 2015.
2. Signals, Systems & Communications – B.P. Lathi, BS Publications, 2003.
3. Signals and Systems – A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn, 1997.
4. Signals & Systems – Simon Haykin and Van Veen, Wiley, 2nd Edition, 2007.

Reference (s)

1. Michel J. Robert, *Fundamentals of Signals and Systems*, MGH International, 2nd Edition, 2008.
2. L. Philips, J.M.Parr and Eve A.Riskin, Signals, Systems and Transforms, 4th Edition, Pearson education, 2014.
3. Signals and Systems – T K Rawat , Oxford University press, 2011.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination /Assignment (%)
Remember	---	---	---
Understand	50	25	---
Apply	50	50	50
Analyze	---	25	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define impulse function.
2. Define autocorrelation.
3. Define a random signal.

Understand

1. Compare Autocorrelation and cross correlation function.
2. Show that the power spectral density of a bandlimited white noise is constant over a range of frequency.

Apply

1. Find out the autocorrelation function of $e^{-at}u(t)$
2. Consider the below data which consists of a set of the third-year students of EEE GMRIT biometric punching time.

No. of students (X)	4+XX	12+XX	18+XX	24+XX	27+XX	19+XX	12+XX
Biometric Time (Y)	08.57	08.58	08.46	09.01	09.13	09.12	09.07

Where XX is last two digits of the student roll number.

i. Find the Mean of X and Y
ii. Identify the covariance and correlation
iii. Develop or fit the linear curve for the above data
iv. Develop a suitable software code after adding Gaussian noise to the above system

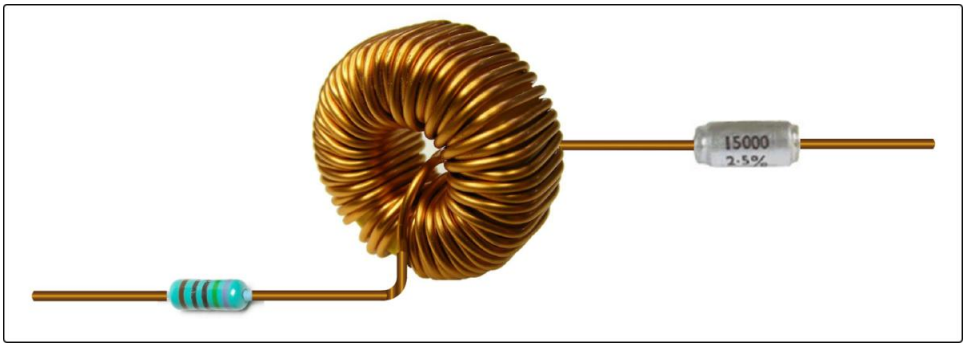
(For Open Book Examination and not for semester end examination)

Analyze

1. Examine the following signals for causality and time invariance
   (i) y(t) = tx(t) (ii) y(t) = x(-t)
2. Justify whether the following signal is energy signal or power signal?.

$$x(t) = \begin{cases} t, o \le t \le 1 \\ 2 - t, 1 \le t \le 2 \\ 0 \; otherwise \end{cases}$$

3. A radio receiver circuit with the following parameters as follows
   R=10 Ohms, L=0.1mH and C=15mF,



   i. Simplify the transfer function of the above circuit, assuming zero initial conditions. assuming that the two states are voltage across the capacitor and current through the inductor, where the output is the voltage across the capacitor
   ii. Simplify the state space model for the above derived transfer function; further derive the discrete model assuming the sampling time is 1msec.
   iii. Develop a suitable software code and draw the output results.

(For Open Book Examination and not for semester end examination)

23EE406 AC Machines Lab

0 0 3 1.5

Course Outcomes

1. Examine performance of alternators using various methods
2. Examine the efficiencies of single-phase transformer
3. Inspect the parameters of single-phase transformer
4. Examine the efficiencies of induction motors
5. Analyze the performance of synchronous motors
6. Assess direct and quadrature axes' reactance for a given synchronous machine

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3		3		3			3	3	3
CO2	3	3	3	3	3		3		3			3	3	3
CO3	3	3	3	3	3		3		3			3	3	3
CO4	3	3	3	3	3		3		3			3	3	3
CO5	3	3	3	3	3		3		3			3	3	3
CO6	3	3	3	3	3		3		3			3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

1. Regulation of a three -phase alternator by synchronous impedance method & m.m.f. method
2. No-load & Blocked rotor tests on three phase Induction motor
3. Brake test on three phase Induction Motor
4. O.C. & S.C. Tests on Single phase Transformer
5. Separation of core losses of a single-phase transformer
6. Sumpner's test on a pair of single-phase transformers
7. Equivalent Circuit of a single-phase induction motor
8. Regulation of three-phase alternator by Z.P.F. method
9. Synchronization of three phase alternator to the Bus bars
10. V and Inverted V curves of a three-phase synchronous motor
11. Determination of X_d and X_q of a salient pole synchronous machine
12. Parallel operation of single-phase transformers

List of Augmented Experiments[1]

1. Estimation of heat developed by primary and secondary windings of a transformer
2. Determination of regulation of synchronous machine by using ASA method
3. Determination of sequence impedances of salient pole synchronous machine
4. Fault analysis of Alternator
5. Synchronization of alternator by using dark & bright lamp method
6. Determination of All day efficiency of transformer
7. Design and development of equivalent circuit of an auto transformer
8. Comparison of volume of copper in two winding transformer and auto transformer
9. Design and development of equivalent circuit of an auto transformer by using MATLAB
10. Maintenance of power transformer
11. Variation in the active and reactive power of an alternator connected to an infinite bus by (a) Varying excitation, (b) varying Mechanical-power input
12. Determine the insulation resistance of a transformer at no load and at full load condition

Reading Material (s)

1. S.G.Tarnekar, P.K.Kharbanda, S.B.Bodkhe, S.D.Nayak,"*laboratory courses in Electrical Engineering*" S.Chand & company limited, 2009
2. Bimbhra P.S., "*Electrical Machines*", 7th edition, Khanna Publishers, 2006.

[1] Students shall opt any one of the augmented experiments in addition to the regular experiments

23EE407 Measurements and Instrumentation Lab

0 0 3 1.5

Course Outcomes

1. Demonstrate suitable methods for measuring R, L and C parameters
2. Interpret the dielectric strength of a given fluid
3. Demonstrate suitable method for calibration of meters
4. Summarize the procedure for measurement of various electrical parameters using sensors and transducers
5. Summarize the procedure for measurement of various non-electrical parameters using sensors and transducers
6. Interpret the characteristics of various sensors

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2						3			3	2	2
CO2	2	2	2						3			3	2	2
CO3	2	2	2						3			3	2	2
CO4	2	2	2						3			3	2	2
CO5	2	2	2						3			3	2	2
CO6	2	2	2						3			3	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments

Any 10 experiments out of which at least 5 experiments from group-A and 5 experiments from group-B.

Group-A: Measurements

1. Measurement of resistance by Kelvin's Double Bridge
2. Measurement of inductance by Maxwell's Bridge
3. Measurement of capacitance by Schering Bridge
4. Measurement of choke coil parameters by using 3-ammeter
5. Measurement of choke coil parameters by using 3-Voltmeter method
6. Measurement of dielectric strength of transformer oil
7. Calibration of single-phase energy meter
8. Calibration of dynamo type wattmeter by using Phantom loading

Group B: Sensors & Transducers

1. Measure the Linear displacement into Electrical signal using LVDT.
2. Strain measurement and Calibration by using Resistance strain gauge
3. Characteristics of photo transistor, photo diode and LDR
4. Characteristics of solar cell.
5. Response of Thermocouple
6. Measurement of Pressure by using Transducers
7. Capacitive Level sensor for liquid level measurement
8. Measurement of moisture using Hygrometer

List of Augmented Experiments[2]

1. Development of level measurement system using proximity sensor
2. Development of automatic door opening system using sensors
3. Development of illumination control system using sensors
4. Development of soil resistance measurement system

Reading Material (s)

1. E.W. Golding, and F.C. Widdis, "*Electrical Measurements and Measuring Instruments*", Reem Publications Pvt. Ltd.,3rd Edition, 2011.
2. A.K. Sawhney, "*Electrical & Electronic Measurements & Instrumentation*", Dhanpat Rai & Co. Pvt. Ltd., 19th Edition, 2011.
3. D.V.S. Murthy, "*Transducers and Instrumentation*", Prentice Hall of India, 2nd edition, 2008.

[1] Students shall opt any one of the augmented experiment in addition to the regular experiments

23ESX01 Employability Skills I

0 0 2 2

Course Outcomes

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1	1	1	1			2	3		3	1	
CO2	1		1	1	1	1			2	3		3	1	
CO3	1		1	1	1	1			2	2		3	1	
CO4	2		2	2	2	2			3	1		3	1	
CO5	3		2	2	2	2			3	1		3	2	
CO6	2		2	2	3	3			3	1		3	3	

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

PART-A

Soft Skills

Building Confidence: Fear? Steps to Overcoming the Fear of Public Speaking?

Self Esteem: Definition? Types of Self Esteem, Causes of Low Self Esteem, Merits of Positive Self Esteem and Steps to build a positive Self Esteem.

Group Discussions (Practice): GD? GD Vs Debate, Overview of a GD , Skills assessed in a GD, Dos & Don'ts, & Conducting practice sessions (Simple Topics).

Motivational Talk: Team Work: Team Vs Group? Stages in Team Building, Mistakes to avoid and Lessons to Learn (Through Stories or Can be a Case Specific)

8 Hours

PART-B

Aptitude Skills

Quantitative Aptitude:

Percentages, Profit and loss, Mixtures and Allegations, Simple Interest, Compound Interest

7 Hours

PART-C

Domain Specific Knowledge

Programmable logic controllers -2

a) Implementation of binary to BCD converter
b) Implementation of combinational circuits
c) Implementation of sequential circuits
d) Basic PLC design for dc motor control
e) Basic PLC design for induction motor control

15 Hours

Total: 30 Hours

Text Book (s)

1. Frederick D. Hackworth and John R. Hackworth, *Programmable Logic Controllers: Programming Methods and Applications*, Pearson India; 1st edition, 2003.
2. Frank Petruzella, *Programmable Logic Controllers*, Tata Mc-Grawhill, 3rd Edition, 2011.

Reference (s)

1. Gary Dunning, Thomson Delmar, "*Programmable Logic Controller*", Cengage Learning, 3rd Edition, 2005.
2. W. Bolton, "*Programmable Logic Controllers*", Newnes – Elsevier, 2015.

23IT306 Object Oriented Programming through Java

3 0 2 4

Course Outcomes

At the end of the course, students will be able to

1. Understand the basic concepts and principles of object-oriented Paradigm
2. Demonstrate the concept of inheritance and packages to solve various problems
3. Understand the role of interfaces to achieve abstraction
4. Interpret various runtime exceptions that appear in the applications
5. Demonstrate parallel processing applications using multi-threading
6. Design interactive applications using Hibernate and spring Framework by establishing database connectivity

CO–PO Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_{12}	PSO_1	PSO_2
1	3	3	2	2	2	2	2	2
2	3	3	3	3	2	3	2	2
3	3	3	3	2	2	2	2	2
4	3	3	3	3	2	3	2	2
5	3	3	2	2	3	2	2	2
6	3	3	3	3	2	3	3	3

Syllabus

Unit I **12+6 Hours**

Introduction to Java

Overview of Object-Oriented Programming principles, Importance of Java to the Internet, Byte code, Data types, arrays, control statements, Classes and Objects– constructors, methods, access control, this keyword, overloading methods and constructors, garbage collection

Features of object-oriented programming–Java History–Computer Programming Hierarchy–Role of Java Programmer in Industry

Practical Components

1. Read in a, b, c and use the quadratic formula. Write a Java program that prints all real solutions to the quadratic equation $ax^2 + bx + c = 0$. If the discriminate b2 -4ac is negative, display a message stating that there are no real solutions?
2. The Fibonacci sequence is defined by the following rule. The first 2 values in the sequence are 1, 1. Every subsequent value is the sum of the 2 values preceding it. Write a Java program that uses both recursive and non-recursive functions to print the nth value of the Fibonacci sequence.
3. Write a program to demonstrate String handling methods and tokenizing given string/text using String Tokenizer class with the following test cases

   Test case-1: "This, is, a, StringTokenizer"

   o/p: This
   ,
   is
   ,
   a
   ,
   StringTokenizer

   Test case-2: INPUT: Input string is: This is example for Java Tokenizer

   OUTPUT: The number of tokens in the string is: 6
4. Write a program to implement matrix operations using multidimensional arrays.

   INPUT: Matrix A:
   1 2 3
   4 5 6
   7 8 9

   Matrix B:
   9 8 7
   6 5 4

3 2 1
OUTPUT (ADDITION)
Matrix A + Matrix B:
10 10 10
10 10 10
10 10 10
OUTPUT (MULTIPLICATION)
Matrix A * Matrix B:
30 24 18
84 69 54
138 114 90

Unit II **12+8 Hours**

Inheritance, Packages & Interface

Inheritance: Hierarchical abstractions, Base class and subclass, Benefits of inheritance, super keyword, final Keyword with inheritance, polymorphism, abstract classes

Packages: Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages, Member access rules. Interface: Defining an interface, differences between classes and interfaces, implementing interface, variables in interface and extending interfaces

Nested–Inner Class & Anonymous Classes–Generic Class Types

Practical Components

1. Write a program for creating one base class for student personal details and inherit those details into the sub class of student educational details to display complete student information.
2. You are tasked with creating a program that calculates and displays the areas of different geometric shapes. The program should exemplify the concept of runtime polymorphism using inheritance and method overriding.

   Test Case 1: Circle Area Calculation

   Input:
   Circle: Radius: 5.0
   Output:
   Area: 78.54

   Test Case 2: Multiple Shapes

   Input:
   Circle:Radius: 10.0
   Rectangle:Width: 5.0, Height: 7.0
   Output:
   Circle:Area: 314.16
   Rectangle:Area: 35.00
3. Write a program to create a package which has classes and methods to read Student admission details.

   Test Case 1: Valid Admission Details

   Input:
   Enter student name: Alice Johnson
   Enter student age: 22
   Enter course: Biology
   Output:
   Student Name: Alice Johnson
   Age: 22
   Course: Biology

   Test Case 2: Different Course

   Input:
   Enter student name: Bob Smith
   Enter student age: 19
   Enter course: Physics
   Output:
   Student Name: Bob Smith

Age: 19
Course: Physics

4. Write a Java program to create a Animal interface with a method called bark() that takes no arguments and returns void. Create a Dog class that implements Animal and overrides speak() to print "Dog is barking".

Unit III **12+8 Hours**

Exception Handling & Multithreading

Exception handling: Concepts and benefits of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally, built-in and User Defined Exceptions.
Multithreading: Definition thread, thread life cycle, creating threads, synchronizing threads
Control Flow in Exceptions– JVM reaction to Exceptions– Inter Communication of Threads– Critical Factor in Thread–Deadlock

Practical Components

1. Create a Java program using multiple catch blocks to handle exceptions arising from array index out of bounds and division by zero, printing specific error messages for each exception.
2. Develop a program to define and handle User Defined Exceptions (make use of throw - throws).
   Test Case 1: Age above 18
   Input: int age = 20;
   Output: Registration successful!
   Test Case 2: Negative Age
   Input: int age = -5;
   Output: Exception: Age must be 18 or above for registration.
3. Design a Java program that showcases the concept of blocking a thread and illustrating how to control the execution flow and coordination between multiple threads in a controlled manner.
4. Introduction to Eclipse Environment.

Unit IV **12+10 Hours**

Java JDBC, Hibernate & Spring Framework

Java JDBC: Introduction, JDBC Driver, JDBC Connectivity steps, Connectivity with MySQL/Oracle. Hibernate Framework: Introduction, Object Relational Mapping tool, Java Persistence API, Hibernate Architecture
Spring Framework: Introduction, Spring Framework
Spring Application, Spring Boot.

Practical Components

1. Establish JDBC connection with Oracle
2. A) Develop a Java program that uses JDBC to establish a connection with a database, inserts data into a specified table, and verifies the successful insertion by displaying the inserted records from the table.
   B) Create a Java program utilizing JDBC to establish a database connection, perform updates and deletions on specified records within a table, and validate the changes by displaying the modified table data.
   Test Case 1: Update Record
   Input: Record ID to update, new values for the record's fields
   Action: Perform the update operation using JDBC
   Output: Display the updated record from the table
   Test Case 2: Delete Record
   Input: Record ID to delete
   Action: Perform the delete operation using JDBC
   Output: Display a message confirming the deletion, or display the modified table without the deleted record
3. Implement Hibernate Example without IDE

4. Develop a Hibernate example in Eclipse to save a "Student" entity to a MySQL database, utilizing Hibernate configuration, Java classes, and libraries, ensuring successful execution and record storage

Total: 48+32 Hours

Textbook (s)

1. H. Schildt, Java: The complete reference, 7th Ed., TMH, 2016
2. T. A. Budd, An Introduction to Object–Oriented Programming, 3rd Ed., Addison Wesley Longman, 2012

Reference(s)

1. Dietal & Dietal, Java: How to Program, 8th Ed., PHI, 2010
2. E. Balaguruswamy, Programming with Java A Primer, 4th Ed., Tata McGraw Hill Companies, 2009
3. C. S. Horstmann and G. Cornell, Core Java, Vol 1. Fundamentals, 7th Ed., Pearson Education, 2014
4. C. Horstmann, BIG JAVA Compatible with Java 5 & 6, 3 rd Ed., Wiley Publishers, 2008

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Lab Examination (%)
Remember	25	35	--
Understand	45	35	--
Apply	30	30	40
Analyze	--	--	20
Evaluate	--	--	40
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. List out 6 different java buzz words
2. List the three OOP principles
3. Define Inheritance
4. List the 5 keywords used in exception handling

Understand

1. Summarize the OOP principles
2. Illustrate the procedure for creating a user defined package
3. Interpret the Thread Life cycle
4. Interpret the Applet Life cycle
5. Define Encapsulation

Apply

1. Implement a java program that read an integer between 0 and 1000 and adds all the digits in the integer
2. Implement an abstract base class shape with two members base and height, a member function for initialization and a function to compute area ( ). Derive two specific classes Triangle and Rectangle which override the function area ( ). Use these classes in a main function and display the area of a triangle and a rectangle.
3. Demonstrate an applet that receives two numerical values as input from the user and then displays the sum of these numbers on the screen.

4. Given are two one dimensional arrays A and B which are sorted in ascending order. Develop a program to merge them into a single sorted array C that contains every item from arrays A and B, in ascending order.
5. Implement a Java program for creating one base class for student personal details and inherit those details into the sub class of student Educational details to display complete student information

Analyse

1. Compare and Contrast between procedure oriented and object oriented programming.
2. Analyze the concurrent programming using threads.
3. Differentiate method overloading and method overriding.
4. Differentiate sleep and suspend.
5. Analyze platform independency of java with the help of JVM.

Evaluate

1. Judge whether Hybernate and spring frameworks are better for java database connectivity.
2. Asses the performance of threads
3. Determine the importance of run time polymorphism
4. Defend why pointer were removed in JAVA
5. Judge why do you java to develop a web based application

23EE502 Control Systems

3 0 2 4

Course Outcomes

1 Develop mathematical models for electrical and mechanical systems in time domain.
2 Analyze the transient and steady state performances for a given system.
3 Examine the system stability using various time domain methods.
4 Evaluate frequency response characteristics using various frequency domain methods.
5 Develop state space model for a given system.
6 Assess the controllability and observability for a given system.

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3				3			3	3	2
CO2	2	1	2	1	2				2			3	2	1
CO3	3	3	3	3	3				3			3	3	3
CO4	3	3	3	3	3				3			3	3	3
CO5	3	3	3	3	3				3			3	3	3
CO6	2	1	2	1	2				2			3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Mathematical Models of Physical Systems

Concepts of Control Systems-Open Loop and closed loop control systems, Classification of control systems, Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems, Block diagram reduction Technique, Signal flow graphs

Effects of feedback

Practical Component

1. Plot the pole-zero configuration in s-plane for the given transfer function for open loop system and close-loop system
2. Simulation of a series R-L-C circuit
3. Simulation of a mass-spring-damper system
4. Series Parallel Feedback connection of Systems

12+8 Hours

Unit II

Time Domain Analysis

Standard test signals, Time response of first and second order systems, time domain specifications, characteristic Equation, Static error constants, Effects of P, PI, PD and PID controllers, Concept of stability, Routh-Hurwitz stability criterion, Difficulties and limitations in RH stability criterion, Root locus concept, construction of root loci

Effects of addition of poles and zeros on root locus plot

Practical Component

1. Step response characteristics for different values of damping factor and undamped natural frequency of any second-order system
2. Unit ramp, unit impulse, and unit acceleration responses of a second order System
3. Simulation of P, PD, PI, and PID controllers for a general second-order system
4. Construct Routh array for a given system and construct Root locus and find the gain K at any point on the root locus

12+8 Hours

Unit III

Frequency Domain Analysis

Frequency response characteristics, Frequency domain specifications, Time and frequency domain parameters correlations, Bode plot, transfer function from the Bode plot, Stability Analysis using Bode plot, Polar plot and Nyquist's stability criterion.

M & N circles

Practical Component

1. PID controller design for a DC motor in frequency domain

2. Polar Plot of a linear system
3. Stability analysis using Bode plots for second-order systems with varying damping ratio (ζ) and different values of gain (K).
4. Stability analysis using Nyquist stability criterion by determining its frequency characteristics

12+8 Hours

Unit IV

State Space Analysis

Concepts of state, state space modeling of physical systems, Representation of state space model in different canonical forms, Transfer function and state space model correlations, Solution of state equations, State Transition Matrix and it's Properties, Basic concept of Controllability and Observability**.**

Diagonalization

Practical Component

1. Convert transfer function to controllable, observable, diagonal, and Jordan canonical forms for a SISO system
2. State Controllability, State Observability, Output Controllability, Output Observability and pole-zero cancellation
3. Find the State transition matrix using Laplace Transforms
4. Controller design in the state space domain

12+8 Hours

Total: 48+32=80Hours

Textbook (s)

1. I.J. Nagrath and M. Gopal, "*Control Systems Engineering*" New Age International (P) Limited, 6th Edition, 2015.
2. Katsuhiko Ogata, "*Modern Control Engineering*", Prentice Hall of India Pvt. Ltd., 4th Edition, 2006.
3. Mario E. Salgado, Graham C. Goodwin, Stefan F. Graebe, "*Control Systems Design*", Pearson Education India; 1st Edition, 2015.

Reference (s)

1. K. Alice Mary and P. Ramana, "*Control Systems*", Universities Press (India) Pvt. Ltd., 1st Edition, 2016.
2. Smarajit Ghosh, "*Control Systems*", Pearson Education, 2nd Edition, 2012.
3. Benjamin C. Kuo, "*Automatic Control Systems*", John Wiley & Sons, 9th Edition, 2011.

Internal Assessment Pattern

Cognitive level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	20	10	---
Understand	20	30	---
Apply	30	30	40
Analyze	30	30	60
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define a closed loop control system
2. List any 4 applications of closed loop control system
3. Define transfer function
4. List 2 advantages of Signal flow graph over Block-diagram reduction technique
5. List any 3 properties of state transition matrix
6. Label different types of frequency domain analysis methods

Understand

1. Differentiate SISO and MIMO systems
2. Explain the traffic control system concepts using open loop as well as closed loop system
3. Derive f-v and f-i analysis
4. Explain different cases in R-H criteria
5. Derive state transition matrix
6. Explain Mason's gain formula

Apply

1. Apply Open Loop and closed loop control systems for the person walking on a road
2. Construct root locus for the open loop T.F function G(s) = (s+2)/(s+1)(s+3)
3. Evaluate transfer function for the state space equation give bellow

   $\dot{x} = AX + BU \;\; y = CX + DU$
4. Construct the Bode plot for given open loop transfer function
   G(s) = (s+2)/(s+1)(s+3)
5. Develop the Nyquist plot for the given open loop transfer function. G(s) = (s+2)/(s+1)(s+3)

Analyze

1. Compare the properties of time domain and frequency domain analysis
2. Analyze the effect of disturbance on the system performance due to feedback
3. Feedback will increase instability of the system. Justify
4. Distinguish the advantage and disadvantages of the root locus and Bode plot
5. Illustrate the variation of root locus with respect to variations in K
6. Formulate the state space model in different canonical forms

23EE503 Electrical Drives

3 0 0 3

Course Outcomes

1. Summarize the speed torque characteristics of different motors
2. Analyze speed control and braking methods of converter fed drives.
3. Examine the speed torque characteristics of chopper fed dc drives
4. Analyze the performance of converter fed induction motor from stator side.
5. Analyze the performance of induction motor from rotor side
6. Outline the operation of converter fed synchronous motor drives

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2				3					3	2	1
CO2	3	3	3				3					3	3	3
CO3	3	3	3				3					3	3	3
CO4	3	3	3				3					3	3	3
CO5	3	3	3				3					3	3	3
CO6	2	1	2				3					3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Control of DC motors by Single Phase & Three Phase Converters

Introduction to Thyristor controlled Drives, Single Phase semi and Fully controlled converters connected to dc separately excited and dc series motors – continuous current operation – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque Characteristics.

Three phase semi and fully controlled converters connected to dc separately excited and dc series motors – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque characteristics.

Speed and Torque characteristics of dc motor, applications of converter fed dc motor.

12 Hours

Unit II

Electrical Braking and Chopper Fed Drives

Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic and Regenerative braking operations. Four quadrant operation of DC motors by dual converters –Closed loop operation of DC motor, Single, Two and four quadrants chopper fed dc separately excited and series excited motors – Continuous current operation – Output voltage and current wave forms – Speed torque expressions – speed torque characteristics.

Four quadrant operation of DC motor by chopper, Closed Loop Operation of chopper dc drive.

12 Hours

Unit III

Control of Induction Motor from Stator Side

Variable voltage characteristics-Control of Induction Motor by AC Voltage Controllers-speed torque characteristics. Control of Induction Motor through Stator Frequency-Variable frequency characteristics-Variable frequency control of induction motor by Voltage source and current source inverters - PWM control – Comparison of VSI and CSI operations –Speed torque characteristics.

Closed loop operation of induction motor drives.

12 Hours

Unit IV

Control of Induction Motor from Rotor Side and Synchronous Motors

Static rotor resistance control, Slip power recovery – Static Scherbius drive – Static Kramer drive –their performance and speed torque characteristics, Separate control & self-control of synchronous motors.

Introduction to vector control

Advantages & applications of slip power recovery scheme.

12 Hours

Total: 48 Hours

Textbook (s)

1. G K Dubey, "*Fundamentals of Electric Drives*", Narosa Publications, 2nd edition, 2010.

2. Vedam Subramanyam, *"Electrical Drives-Concepts and Applications"*, McGraw Hill Education, 2nd Edition, 2017.
3. R. Krishnan, "*Electrical drives: Modeling, Analysis and Control*", Prentice Hall of India., 1st Edition, 2015.

Reference (s)

1. B.K.Bose, "*Modern Power Electronics and AC Drives*", Prentice Hall of India, 1st Edition, 2015.
2. S K Pillai, "*A First course on Electrical Drives*", New Age International (P) Ltd, 2nd Edition, 2012.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Examination (%)
Remember	20	10	---
Understand	20	30	---
Apply	30	40	60
Analyze	30	20	40
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define Drive
2. Describe the block diagram of electric drive
3. List any four speed control methods of Induction motor

Understand

1. Explain the operation of fully controlled converter fed DC motor
2. Compare the performance of single phase full converter and half –wave converters
3. Explain the operation of chopper fed DC motor

Apply

1. Develop a single phase full converter for separately excited DC motor
2. Identify a suitable converter for an induction motor for variable speed applications
3. Compute the RMS value of the output voltage for a single phase full converter
4. Develop an equivalent circuit for static rotor resistance method
5. A compressors supplying high-pressure clean air to fill gas cylinders and this is controlled by a single-phase, full-wave ac voltage controller of 120-V, 60-Hz, operating with a conduction angler γ= l 30°.
   a) When compressor power factor varies from 0.5 at starting to 0.85 at full load, determine the corresponding range of the delay angle α.
   b) Determine the ratio of the output voltage to input voltage corresponding to the conditions of part (a.) **(For open book Examination not for semester end examination)**

Analyze

1. Compare the performance of the converter fed DC motor under motoring and braking conditions
2. Examine the regenerative braking of DC series motor
3. Compare the performance of synchronous motor by using self and separate control
4. The DC drives are widely used in applications requiring adjustable speed control, an electric vehicle is controlled by a basic chopper circuit consists of a series combination of R = 10 Ω, an L= 15×10^{-3}H and a back emf Eo = 18 V. The period of the chopper is T= 0. 20 ms. The de supply voltage is 220 V.
   a) Find the critical value of the on-time for which the minimum value of the load current is zero.
   b) Find the value of the maximum load current corresponding to the conditions of part (a)
   c) Assume that ton = 0.5 T, determine the minimum and maximum values of the instantaneous load current. **(For open book Examination not for semester end examination)**

23EE504 Power System Protection

3 0 0 3

Course Outcomes

1. Outline the working of various types of circuit breakers
2. Identify suitable Electro mechanical relays for power system equipment.
3. Summarize the construction and working of differential and distance relays
4. Identify protection schemes for Transmission lines and Busbars.
5. Analyze the protection schemes for Generators and Transformers.
6. Outline the operation of electrostatic and digital relays

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1		2	3					3	2	1
CO2	2	1	2	1		2	3					3	2	1
CO3	3	2	3	2		3	3					3	3	2
CO4	3	2	3	2		3	3					3	3	2
CO5	2	1	2	1		2	3					3	2	1
CO6	3	2	3	2		3	3					3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Circuit Breakers

Basics of Protection & its significance, Circuit Breakers: Elementary principles of arc interruption, Restriking and Recovery voltages - Restriking Phenomenon, Average and Max. RRRV- Current Chopping and Resistance Switching - CB ratings and Specifications, Auto-reclosures, Description and Operation of Oil Circuit breakers, Air Blast Circuit Breakers, Vacuum Circuit Breakers and SF6 circuit breakers, MCB and MCCBs, Isolators.
Difference between a Fuse, an Isolator and a Circuit breaker.

12 Hours

Unit II

Electromagnetic Relays

Principle of operation and construction of attracted armature, Balanced beam, induction disc and induction cup relays. Instantaneous, DMT and IDMT relays.
Over current/ Under-voltage relays, Directional relays, Differential and percentage differential relays, Translay relay, Universal torque equation,
Distance relays- Impedance, Reactance and Mho relays.
Fundamental requirements of protective relays, Types of protection.

12 Hours

Unit III

Power system components protection

Line protection -Over current, carrier current and three-zone distance relay protection using impedance relays, ZnO and rod gap Lightning arresters, grounding wires, Peterson coil.
Bus bar protection – Differential protection
Generator Protection-Protection of generators against stator faults, rotor faults, restricted earth fault and inter-turn fault.
Transformer protection - Percentage differential protection, Buchholz relay protection.
.*Voltage surge, lightning.*

12 Hours

Unit IV

Static & Digital Relays

Static Relays-Introduction, Static relay components, Comparators – Amplitude and phase, Static over current relay, Static distance relay and Static poly-phase relay.
Digital Relays- Introduction, Digital logic communication, Microprocessor based over current, impedance, reactance & Mho relays, relay testing, static relays versus electromagnetic relays
Static relays versus electromagnetic relays.

12 Hours

Total: 48 Hours

Textbook (s)

1. Badri Ram and D.R.Viswakarma, "*Power System Protection and Switchgear*", Tata McGraw Hill Education Private Limited, 2nd Edition, 2013
2. J. B. Gupta, "*Switchgear and Protection*", S. K.Kataria & Sons, 1st Edition, 2009.

Reference (s)

1. V.K. Mehta and Rohit Mehta, "*Principles of Power Systems*", S. Chand & Company Ltd., 2005.
2. Sunil S Rao, "*Switchgear and Protection*", Khanna Publishers, 13th Edition 2019
3. Paithankar and S. R. Bhide, "*Fundamentals of Power System Protection*", PHI publications, 2nd Edition 2013.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Examination (%)
Remember	40	20	---
Understand	40	40	---
Apply	20	40	60
Analyze	---	---	40
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Label the circuit diagram of relay
2. List the advantages of vacuum circuit breaker
3. Define arc voltage
4. List any three problems associated with differential relay

Understand

1. Formulate the expression for restriking voltage
2. Illustrate the SF6 circuit breaker with neat diagram
3. Explain any three types of lightning arresters
4. Classify voltage balance differential relay and translay relay
5. Explain the working principle of restricted earth fault relay for the protection of stator winding of alternator

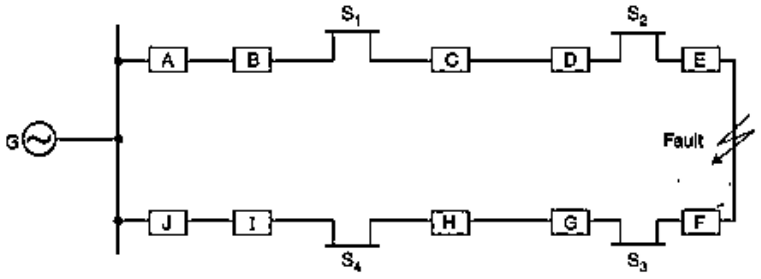
Apply

1. For 132kV system the reactance and capacitance up to location of circuit breaker is 3ohms, and 0.015μF, respectively. Find i) frequency of transient oscillation, ii) maximum value of restriking voltage iii) RRRV
2. A star connected 3-phase,10MVA,.7.5 kV alternator has a per phase reactance of 10%. it is protected by Merz-Price circulating current principle which is set to operate for fault currents not less than 200A. Find the value of earthling resistance to be protected in order to ensure that only 10% of the alternator winding remains unprotected.
3. Find the time of operation of a 5 amp 3 second over current relay having current setting of 125% and time setting multiplier of 0.6 connected to supply circuit through a 400/5 current transformer when the circuit carries a fault current of 4000A. Use the following table

Operating Time	2	4	6	8	10	12
PSM	2	2.5	3	3.5	4	4.5

4. Fig shows the single line diagram of a typical ring main system consisting of one generator supplying four sub-stations *S*1, *S*2, *S*3 and *S*4. In this arrangement, power can flow in both directions under fault conditions. In this system, various power stations or sub-stations are interconnected by alternate routes, thus forming a closed ring. In case of damage to any section of the ring, that section

may be disconnected for repairs, and power will be supplied from both ends of the ring, thereby maintaining continuity of supply Therefore, it is necessary to grade in both directions round the ring. Select optimal location for relays and identify their time settings so that only faulty section of the ring is isolated under fault conditions. Justify your answer. **(For Open Book Examination and not for semester end examination)**



Analyze

1. Distinguish between Electrostatic and Electromagnetic relays
2. Vacuum circuit breakers are mostly suitable for rural areas. Justify
3. An alternator is used in a generating station and it was observed that the following issues are being faced in alternator operation.
   (i) one-phase open circuits
   (ii) unbalanced loading
   (iii) motoring
   (iv) loss of synchronism.
   Can relays be used to protect an alternator against the above issues. Justify your answer with suitable protection schemes. **(For Open Book Examination and not for semester end examination)**

23EEC11 Electrical Vehicle Technologies

3 0 0 3

Course Outcomes

1. Outline various electric and hybrid vehicle architectures
2. Analyze the operations of vehicle dynamics
3. Select optimal vehicle technology based on architecture and dynamics for a particular application
4. Outline various power electronic converters for electric vehicles
5. Outline various motors for electric vehicles
6. Analyze the performance of power electronic converter based electric drives

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		1	2			2	3					3	2	1
CO2		3	3			3	3					3	3	3
CO3		3	3			3	3					3	3	3
CO4		2	2			2	3					3	2	2
CO5		1	2			2	3					3	2	1
CO6		3	3			3	3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Electric and Hybrid Electric Vehicles

Sustainable transportation, Brief history of electric vehicles (EV's), Hybrid electric vehicles, Fuel cell vehicles, Architectures of EV, Series HEV, Parallel HEVs, Diesel HEVs, PHEV & FCEV, Hybridization ratio, Interdisciplinary Nature of HEVs, Challenges and key technology of HEVs.

Recent EV models

12 Hours

Unit II

Vehicle Dynamics

General description of vehicle movement, Vehicle Resistance - Rolling Resistance, Grading Resistance, Aerodynamic Drag, Tire–Ground Adhesion and Maximum Tractive Effort- Power Train Tractive Effort and Vehicle Speed, Vehicle performance -Maximum Speed of a Vehicle, Gradeability, Operating fuel economy-Fuel Economy Characteristics of Internal Combustion Engines, Braking performance.

Techniques to improve vehicle fuel economy

12 Hours

Unit III

Power Electronics in HEVs

Power electronics converters used in a series HEV, Schematics of a power converter, Rectifiers used in HEV - Ideal Rectifier, Practical Rectifier, Buck Converter Used in HEVs -operating principle, Voltage source inverter, Current source inverter, Isolated bidirectional DC–DC converter, EV and PHEV battery chargers-charger architecture, Emerging power electronics devices, Thermal management of HEV power electronics

Circuit Packaging

12 Hours

Unit IV

Electric Machines and Drives in HEVs

Introduction to induction motor drives and control

Principle of operation and analysis of BLDC motor Drive, PMSM drive and SRM drive.

Doubly salient permanent magnet machines

12 Hours

Total: 48 Hours

Textbook (s)

1. Chris Mi, Abul Masrur and David Wenzhong Gao, *"Hybrid Electric Vehicles-Principles and Applications with Practical Perspectives"*, John Wiley & Sons, Ltd., 1st Edition, 2011.
2. James Larminie and John Lowry, "*Electric Vehicle Technology Explained"*, Wiley, 1st Edition, 2003.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi "*Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*", CRC Press, 2005.

Reference (s)

1. Tom Denton, *"Electric and Hybrid Vehicles"*, Taylor & Francis, Ist Edition, 2018.
2. Wei Liu, *"Hybrid Electric Vehicle System Modeling and Control",* General Motors USA, John Wiley & Sons, Inc., 2017.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Examination (%)
Remember	25	25	---
Understand	25	25	---
Apply	25	25	50
Analyze	25	25	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. List various lighting systems and components
2. Label VI Characteristics of MOSFET & IGBT
3. List various PM motors used in EV technology
4. Define power train tractive effort

Understand

1. Explain in detail about layout of Electric vehicle
2. Explain the working principle of BLDC motor
3. Explain vehicle power transmission characteristics
4. Explain bi-directional DC-DC converter

Apply

1. Develop the layout of Series hybrid electric vehicle
2. Identify the techniques to improve the vehicle fuel economy
3. Develop the buck converters used in HEV's
4. Identify various losses in PM magnet machines used in EV's
5. Mr. Rahul, a businessman, needs to travel daily on an average covering 100km which consists of 70 km highway drive and 30 km city drive. He is currently using a diesel vehicle and wants to shift to non-polluting/less polluting vehicle. Help him identify which vehicle he can opt so that it would cater to his needs as well as reduce his vehicle carbon footprint. Justify your selection by giving a detailed layout of architecture of the proposed vehicle and by relating the driving requirements of Mr. Rahul with the operating characteristics of the vehicle. (make use of EV/HEV specifications available in the market)
   (For Open Book Examination and not for semester end examination)

Analyze

1. Analyze the factors leading to disappearance and resurgence of EV's
2. Analyze the Vehicle Power Plant and Transmission Characteristics
3. Analyze the EV and PHEV Battery Chargers
4. Analyze various charactistics of PM magnet motors
5. Analyze the reasons favoring the simultaneous emergence and existence of various electric vehicle architectures across the world. (Hint: Do all electric vehicle configurations have practical applications)
   (For Open Book Examination and not for semester end examination)

23EEC21 Green Energy Technologies

3 0 0 3

Course Outcomes

1. Illustrate the wind energy conversion systems
2. Recognize the impacts of temperature and insolation on PV electrical characteristics
3. Estimate the green energy dependent parameters
4. Design and explore the economic viability of the grid connected PV systems
5. Illustrate the Building integrated photovoltaics system
6. Identify the relevant standards related to the grid connection requirements of PV

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		1	2			2	3					3	2	1
CO2		3	3			3	3					3	3	3
CO3		3	3			3	3					3	3	3
CO4		3	2			3	3					3	3	3
CO5		1	2			2	3					3	2	1
CO6		2	3			3	3					3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-I Wind Energy

Introduction to wind energy - Potential of wind electricity generation in India and its current growth rate Types of wind turbines - Power in the wind, temperature and altitude correction for air density - Impact of tower height - maximum rotor efficiency - Wind turbine generators, synchronous generators and asynchronous induction generator - Speed control for maximum power, Idealized wind turbine power curve, cut in wind speed, cut out wind speed, Rated wind speed, wind farms for bulk power supply

Indirect grid connection systems

12 Hours

Unit-II Solar PV Energy

Introduction of solar energy - Solar spectrum - Altitude angle of the sun at Solar noon, tilt angle of a PV module, Solar position at any time of day. Direct Beam Radiation, Diffuse Radiation, Reflected Radiation and Tracking system. Solar Radiation Measurements

Photovoltaic electrical characteristics - A generic photovoltaic cell, the simplest equivalent circuit for a photovoltaic cell, PV cell - cells, modules and arrays, voltage and current from a PV module - the PV *i–v* curve under standard test conditions - Impacts of temperature and insolation on *i–v* curves - Shading impacts on i–v curves, Impact of shading on PV cell -, importance of maximum power point tracking and its methods

Introduction to crystalline silicon technologies **12 Hours**

Unit-III Grid-connected PV systems

Grid-connected systems, interfacing with the utility, dc and ac rated power, derating a PV array to a PTC, ac rating, the ''peak-hours'' approach to estimating PV performance, Grid-connected system sizing - system trade-offs, amortizing costs - stand-alone PV systems, Islanding and anti-islanding systems estimating the load, the inverter and the system voltage,

Batteries, Importance of storage capacity in Grid connected system, sizing the PV array, hybrid PV systems and stand-alone system design..

Introduction to PV powered water pumping

12 Hours

Unit-IV Building integrated photovoltaics & International Regulations

Introduction to Building integrated Advantages and challenges of building integrated photovoltaic PV – Design of building envelope integration, PV integration options - Shading system ,Rain scree system , Curtain wall systems, Stick system curtain wall, Unitized system, Double-skin façade,- Shading systems, Principles of construction, Integration of PV modules.

Grid Requirements for PV - International Regulations, Response to Abnormal Grid Conditions, Power Quality, Anti-islanding Requirements

Array wiring

12 Hours

Total: 48 Hours

Text Book(s)

1. Gilbert M. Masters, "*Renewable and Efficient Electric Power Systems*", John Wiley & Sons, 1st Edition, 2013.
2. Remus Teodorescu, Marco Liserre and Pedro Rodriguez, "*Grid Converters for Photovoltaic and Wind Power System*", John Wiley & Sons, 1st Edition, 2011.

Reference Book(s)

1. Simon Roberts and Nicolò Guariento, "*Building Integrated Photovoltaics: A Handbook*", Springer Science & Business Media, 1st Edition, 2009.
2. Felix A. Farret, M. Godoy Simoes, "*Integration of Alternative Sources of Energy*", John Wiley & Sons, 1st Edition, 2013.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book / Assignment Examination (%)
Remember	20	20	---
Understand	50	50	---
Apply	30	30	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define photovoltaic.
2. What is air mass ratio?
3. Write the expression of Planck's law.
4. What is Capacity factor for PV Grid-Connected Systems?
5. State any two anti-islanding requirements.

Understand

1. Write short notes on (i) Altitude Correction for Air Density (ii) Impact of tower height
2. Find the air density (a), at 15◦ C (288.15 K), at an elevation of 2000 m (6562 ft). Then (b) find it assuming an air temperature of 5◦ C at 2000 m.
3. Derive the expression of fundamental relationship for the power delivered by the rotor and obtain Betz efficiency.
4. Describe in detail about rainscreen cladding and curtain wall systems.
5. With neat sketch explain the principal components in a grid-connected PV system using a single inverter.

Apply

1. A 40-m, three bladed wind turbine produces 600 kW at a windspeed of 14 m/s. Air density is the standard 1.225 kg/m3. Under these conditions,
   a) At what rpm does the rotor turn when it operates with a TSR of 4.0?
   b) What is the tip speed of the rotor?
   c) If the generator needs to turn at 1800 rpm, what gear ratio is needed to match the rotor speed to the generator speed?
   d) What is the efficiency of the complete wind turbine (blades, gear box, generator) under these conditions?
2. Consider a PV array rated at 1 kW under standard test conditions. Module nominal operating cell temperature (NOCT) is 47◦ C (see Section 8.6). DC power output at the MPP drops by 0.5%/◦ C above the STC temperature of 25◦ C. Estimate its ac output under PTC conditions if there is a 3% array loss due to mismatched modules, dirt loss is 4%, and the inverter has an efficiency of 90%.

3. A certain water heater is when operated from 120 V a.c will deliver a power of 2.88 kW. Now this heater (electrical resistance heating element) is directly connected to the PV system. Assume that you have 4 identical PV modules each with the I-V curve as shown in figure. Plot the I-V curves of different combinations of PV modules and decide which combination will give the most energy in a day time. Justify. **(For Open Book Examination and not for semester end examination)**
4. Identify the size of wind turbine power rating that is required to be installed to meet the annual energy requirement of an industry is 20000 kWh and also approximate cost of the wind turbine.
   Assume the following data for design of wind turbine:
   (i)Propeller type wind machine is used
   (ii)Wind speed at 15 m height is 5 m/sec (if the turbine hub is placed at the height other than 15 m, the wind speed should be estimated as shown in "vertical wind speed variation section".
   Assume any data required and justify your assumption
   (For Open Book Examination and not for semester end examination)

23EEC31 Micro and Smart Grid Technologies

3 0 0 3

Course Outcomes

1. Summarize the concepts of various operating modes in a microgrid
2. Outline the control strategies of a microgrid
3. Examine the dynamics in micro grid models
4. Outline the concepts related to design of smart grid
5. Summarize the regulations of smart grid
6. Identify various market models in smart grid

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		1	2			2	3					3	2	1
CO2		3	3			3	3					3	3	3
CO3		3	3			3	3					3	3	3
CO4		3	2			3	3					3	3	3
CO5		1	2			2	3					3	2	1
CO6		2	3			3	3					3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Microgrids: Concept, Modes of Operation and Control

Introduction, Structure, Modes of operation, Overall representation of the grid-connected microgrid, Microgrid bus, Microgrid representation in the islanded operation, Model control mechanism for connected distributed generators in a microgrid, Speed control of classical distributed generators, Control of inverter-based distributed generators, Control structure in grid-connected mode, Control structure in islanded model.

Global architecture representation **12 Hours**

Unit II

Microgrid Dynamics and Modeling

Introduction, Distribution network (Main Grid) and connection modeling, Distribution network modeling, Mechanical part and frequency regulation loop, Voltage regulation, Modeling of connection between the main grid and microgrid, Modeling of the medium voltage transmission lines

Adaptation between the per units and SI units **12 Hours**

Unit III

Introduction to Smart Grid

Definition of smart grid, Justification for smart grid, History of smart grid evolution, Characteristics and benefits of smart grid, Vision and realization, Comparison between smart grid and existing electrical grid system in India, Advanced metering infrastructure.

Basic components of smart grid **12 Hours**

Unit IV

Regulations of Smart Grid

Regulation and funding of smart grid, Regulation and economic models, Evolution of the value chain, Market regulation and standardization of smart grid

Market Models for Smart Grid

Demand response, Tariff design, Time of the day pricing (TOD), Time of use pricing (TOU), Consumer privacy and data protection, Cost benefit analysis of smart grid projects

Smart grid for smart cities **12 Hours**

Total:48 Hours

Textbook (s)

1. H. Bevrani, B. François and T. Ise, *"Microgrid Dynamics and Control"*, John Wiley & Sons, 1st Edition, 2017.
2. Jean Claude Sabonnadière and Nouredine Hadjsaïd, "Smart Grids", Wiley-ISTE, IEEE Press, May 2012.
3. James Momoh, *"Smart Grid: Fundamentals of Design and Analysis"* – Wiley, IEEE Press, 2012

Reference (s)

1. N. D. Hatziargyriou*, "Microgrids Architecture and control",* IEEE Press Series, John Wiley & Sons Inc, 1st Edition, 2013.
2. El-Shahat, Adel, Rami J. Haddad, YouakimKalaani. "*Smart Grids Technology Fundamentals - New Course*" *Proceedings of the ASEE Southeastern Section Annual Conference* Gainesville, FL: American Society for Engineering Education, 2015.
3. "*Smart grid handbook for regulators and policy makers*", Indian Smart Grid Forum (ISGF) Tech. Rep., Nov. 2017.
4. Kumar et al. 2013, Sanjeev Kumar, N.S. Sodha, and K. Wadhwa, "*Dynamic tariff structures for demand side management and demand response: An approach paper from India*", 2013 ISGAN issue brief Available for download from http://indiasmartgrid.org/en/knowledge-center/Reports/Dynamic \%20Tariffs \%20White \%20Paper.pdf

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Examination (%)
Remember	25	25	---
Understand	50	50	---
Apply	25	25	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Microgrid.
2. What do you mean by main grid?
3. Define Smart grid
4. What do you mean by time of delay pricing?

Understand

1. Explain the operating modes in a microgrid.
2. Interpret the difference between existing grid and smart grid structure.
3. Summarize the concept evolution of value chain.
4. Outline the role of consumers and new players in the value chain?

Apply

1. Identify the type of control in a islanded microgrid?
2. Build the model of medium voltage transmission lines?
3. Identify the various components used in smart grid applications?
4. Identify a suitable business model for smart grid?
   There is a beautiful island known as Kona Seema Island near Kerala Backwaters, nearly 10 KM from the coast in Andhra Pradesh, In this island, in addition to the local renewable based power sources, a major portion of the island is powered from the main grid AP. One fine day due to some event, the grid is identified to have been disconnected with the main grid, with only a small amount of renewable energy power left to power the island. As a power engineer, identify the significant changes in the representation of the overall network, and sketch it in form of some neat diagrams. Further identify the possible reasons for the occurrence of such events and suggest some suitable control strategies to manage power under such circumstances to maintain life and tourism in the beautiful island. **(For Open Book Examination and not for semester end examination)**

5. Protection of the critical infrastructure is the primary objective of any nation and the power sector assumes top priority as all other sector depends directly and indirectly on the power sector. With the convergence of electrical technologies, information technologies and operational technologies in a smart grid, security of control systems and data protection is extremely important. Many attacks have been launched in Industrial and Control System. Identify the different types of attacks and suggest proactive measures to address data protection and potential cyber security issues with necessary block diagram. Also, write the instruments need to be procured for monitor and control with justification. **(For Open Book Examination and not for semester end examination)**

Analyze

1. Compare the grid connected mode with islanded mode of operation in a microgrid.
2. Contrast the dynamics of frequency regulation loops in microgrids.
3. Analyze the characteristics of smart grids.
4. Examine the cost benefit analysis of a smart grid.
   As the cyclone is hitting to the costal belt in India every year, The Central Government has decided to upgrade the electrical communication system in the costal district of each state. As a technical engineer, the duty has assigned that, you have to inspect the locality and to finalize the smart communication methodology which will be collaborated with Gas Insulated Substation in your locality. As an expert in this area, inspect the details of some suitable instruments with justifications which need to be procured for unmanned work for grid scenario for the stability of the grid structure in your locality. Justify your answer with proper descriptions. **(For Open Book Examination and not for semester end examination)**
5. In Visakhapatnam assume a microgrid is in parallel with the main grid. Due to a severe cyclone the micro-grid is been isolated from remainder of the utility system- intentional islanding mode. In this mode, DG inverter system operates in voltage control mode to provide constant voltage to the local load. During grid connected mode, the Microgrid operates in constant current control mode to supply power to the main grid. Now in this scenario examine a scheme to minimize the voltage and frequency deviations at both local load level and at system level. **(For Open Book Examination and not for semester end examination)**

23EE017 Electrical Machine Design

3 0 0 3

Course Outcomes

1. Summarize electrical materials as per IS standards
2. Make use of various design concepts in construction of DC machines and transformers
3. Analyze the effect of design parameters on output of DC machines and transformers
4. Examine the effect of specific loadings in the design of AC rotating machines
5. Make use of various design concepts in construction of induction motor
6. Apply various design concepts in construction of synchronous machine

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2					2				3	2	1
CO2	3	2	3					3				3	3	2
CO3	3	2	3					3				3	3	2
CO4	3	2	3					3				3	3	2
CO5	3	2	3					3				3	3	2
CO6	3	2	3					3				3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction & DC Machines

Major considerations in Electrical Machine Design, Electrical Engineering Materials according to IS standards, Review of basic principles. DC Machines - Constructional details, output equation, choice of specific electric and magnetic loadings-separation of D and L for rotating machines, estimation of number of conductors/turns-coils-armature slots-conductor dimension-slot dimension, Choice of number of poles, length of air gap.

Choice of specific electric and magnetic loadings according to IS 1180-1989 & IS 2026-2011

12 Hours

Unit II

Transformers

Output equation, kVA output for single and three phase transformers, Window space factor, Overall dimensions, Transformer windings-coil design, determination of number of turns and length of mean turn of winding, leakage reactance of windings, design of Tank and cooling tubes, methods of cooling of transformers.

Various cooling techniques

12 Hours

Unit III

Induction Motors

Output equation of Induction motor, Main dimensions, design of stator winding and slots, Length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor.

Choice of specific electric and magnetic loadings according to IS 325-1996.

12 Hours

Unit IV

Synchronous Machines

Output equations, Main dimensions, Short circuit ratio, Length of air gap, shape of pole face, Armature design, length of mean turn, design of rotor, Design of damper winding, Design of field winding, Design of turbo alternators – Rotor design.

Choice of specific electric and magnetic loadings

12 Hours

Total: 48 Hours

Textbook (s)

1. Sawhney. A.K., A. Chakrabarti, *"A Course in Electrical Machine Design"*, Dhanpat Rai & Sons, 6th edition, 2014.
2. Sen. S.K., *"Principles of Electrical Machine Designs with Computer Programmes"*, Oxford and IBH Publishing Co. Pvt. Ltd., 2nd edition, 2011.
3. A. Nagoor Kani, *"A Simplified Text in Electrical Machine Design"*, RBA Publications, 2nd edition, 2013.

Reference (s)

3. M.G. Say, *"Alternating Current Machines",* Pitman Publishing Ltd., 4th edition, 2012.
4. Mittle V.N. and Mittle A, *"Design of Electrical Machines"*, Standard Publications and Distributors, New Delhi, 2012.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Examination (%)
Remember	20	20	---
Understand	20	20	---
Apply	40	20	50
Analyze	20	40	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define rating of Electrical machine
2. Define specific magnetic loading
3. List the parts of electromagnetic rotating machines
4. Define critical speed
5. List the types of synchronous machines.

Understand

1. Explain different types of magnetic materials
2. Illustrate total magnetic loading
3. Formulate the expression for output equation of a DC machines
4. Indicate different cooling methods used for dry type transformer
5. Represent the advantages of using open slots

Apply

1. Execute the applications of insulating materials
2. Demonstrate unbalanced magnetic pull
3. Develop the relationship between the number of commutator segments and number of armature coils in DC generator
4. Demonstrate the use of end rings
5. Use of damper winding in synchronous machine

Analyze

1. Classify the electrical engineering materials
2. Conclude why circular coils are preferred in transformers
3. Differentiate real and apparent flux density
4. Contrast shell type and core type transformer
5. There is an old Tram Vehicle which was not used for more than 10 years. However, due to some requirement its working is to be restored. Up on preliminary inspection by an engineer it was diagnosed that the tram employed a DC series motor for operation with mechanical gear wheel arrangement for speed control. Further, it was also found that the entire systems in the tram are intact i.e., no physical damages were identified and ideally the tram should start working. But, when the engineer tried to start the tram the motor could not start.
   I. Identify the proper reasons for the motor not starting.
   II. Having known the reasons why the motor is not starting, how would you bring it back to working condition.
   III. Since, the mechanical speed control systems are inefficient, suggest a modern control system for the motor with illustrations. Justify your selection.

   (For Open Book Examination and not for semester end examination)

6. A steel plant is constructed to be operated on a DC supply. The main functional units in the plants are depicted below.
    a. Blast furnace (BF)
    b. Steel melt shop (SMS)
    c. Rolling mill

I. To transport coal/ raw materials over conveyor belt to blast furnace (BF). The molten steel is then transferred to steel melt shop (SMS) in wagons. The conveyor belt operates at a variable load at constant speed. Suggest a suitable motor for conveyor belt system and justify your answer.

II. The molten metal from BF which is received by wagon is lifted by electrically operated trolley (EOT) crane for superheating the molten metal to $6000^{o}C$ to remove impurities and moisture. The entire working of the SMS plant is based on the operation of the EOT crane which is used to lift and tilt the ladle (bucket) containing molten metal into the heating furnace. The weight of the molten metals will be in tons and the operation must be carried out very slowly in order to avoid casualties. Suggest a suitable motor for EOT crane and justify your answer.

III. The molten metal from SMS is then sent to continuous casting department (CCD) where it is cooled down, solidified and cut into rectangular blooms of uniform length. The blooms are then transferred to mills where they are made into different shapes for consumer use. The output products from mills are circular wires, L and I angles, rectangular sheets etc.
    a. A motor is required to compress the bloom such that the above shapes can be obtained.
    b. Another motor is required to roll the compressed bloom into required final product.
    c. Finally, a motor is used to transfer the product to the warehouse using a conveyer belt.

Suggest suitable motors for the operations mentioned in a,b,c in the above question and justify the same. **(For Open Book Examination and not for semester end examination)**

23EE018 High Voltage DC Transmission

3 0 0 3

Course Outcomes

1. Compare HVDC and HVAC Transmission systems
2. Analyze the operation of 6 and 12 pulse converters
3. Apply various control strategies to HVDC links
4. Develop power flow analysis in HVDC Transmission system
5. Identify protective schemes for different operating conditions
6. Analyze the effect of harmonics and elimination methods

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2			2	3					3	2	2
CO2	3	3	3			3	3					3	3	3
CO3	3	2	3			3	3					3	3	2
CO4	3	3	3			3	3					3	3	3
CO5	3	2	3			3	3					3	3	2
CO6	3	3	3			3	3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Basic Concepts & Analysis of HVDC Converters

Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC &DC Transmission, Application of DC Transmission System – Planning & Modern trends in DC Transmission.

Choice of Converter configuration – analysis of Graetz circuit – characteristics of 6 pulse converters – Cases of two 3 phase converters in star –star mode – their performance.

Characteristics of 12-pulse converters, characteristics of n-pulse converter

12 Hours

Unit II

Converter & Reactive Power Control in HVDC

Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system; Starting and stopping of DC link; Power Control.

Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategies, AC Filters.

Shunt capacitors-synchronous condensers, Static VARS

12 Hours

Unit III

Power Flow Analysis, Converter Fault & Protection

Modeling of DC Links-DC Network-DC Converter-Controller Equations-Solution of DC load flow – PU System for DC quantities-solution of AC-DC power flow-Simultaneous method-Sequential method.

Converter faults – protection against over current and over voltage in converter station – surge arresters – smoothing reactors – DC breakers.

corona effects on DC lines-Radio interference, *Audible noise-space charge field*

12 Hours

Unit IV

Harmonics & Filters

Generation of Harmonics –Characteristic harmonics, calculation of AC Harmonics, Non- Characteristic harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters.

Design of High pass filters.

12 Hours

Total=48 Hours

Textbook (s):

1. K. R. Padiyar, "*HVDC Power Transmission Systems: Technology and system Interactions*", New Academic Science publishers, 3rd Edition, 2017
2. S. Rao "*EHVAC and HVDC Transmission & distribution Engineering*", Khanna publisher, 3rd Edition (reprint), 1999

Reference (s):

1. J. Arrillaga, "*High Voltage Direct Current Transmission*", The Institution of Engineering and Technology, 1998.
2. Edward Wilson Kimbark, "*Direct Current Transmission*", John Wiley & Sons, 1st Edition, 1971.
3. E. Uhlmann, *"Power Transmission by Direct Current"* , B. S. Publications, 2nd edition, 2012

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book / Assignment Examination (%)
Remember	20	20	---
Understand	40	30	---
Apply	10	40	40
Analyze	30	10	60
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define firing angle and extinction angle
2. List the advantages of HVDC transmission
3. List the various modes of operation of 6 pulse converter

Understand

1. Explain the protection of converter against over voltages
2. Contrast HVDC and HVAC transmission systems
3. Illustrate the working principle of 12 pulse converter
4. Outline the effect of corona on DC lines
5. Explain the various control strategies of converter

Apply

1. Identify the applications of HVDC transmission system
2. Model a suitable filter for reduction of 3rd and 6th harmonic components
3. Develop an algorithm for DC power flow
4. In the erection and commissioning of a HVDC station, suggest a suitable HVDC link that is advantageous for DC transmission. Also facilitate the strategic planning using one of the modern trends in DC transmission. **(For Open Book Examination and not for semester end examination)**

Analyze

1. Analyze 12 pulse converter in detail
2. Compare AC and DC power flows
3. Design the high pass filter having cutoff frequency of 200MHz
4. Enumerate the suggested and most advantageous converter control strategies (alternate control strategies) in the HVDC transmission network by considering the probable effects of the source inductance on the system. Will there be any reactive power requirements in steady state that need to be addressed in the control strategy suggested by you – Justify. **(For Open Book Examination and not for semester end examination)**

23EE019 Special Electrical Machines

3 0 0 3

Course Outcomes

1. Outline the construction & working of stepper Motor
2. Outline the construction & working of switched reluctance Motor
3. Analyze the performance of switched reluctance Motor & stepper motor
4. Outline the construction & working of different types of Permanent Magnet brushless D.C. Motors
5. Examine the performance of square wave & sine wave Permanent Magnet brushless D.C. Motors
6. Analyze the performance of different single phase Special Machine for a particular application

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2				3					3	2	1
CO2	2	1	2				3					3	2	1
CO3	3	3	3				3					3	3	3
CO4	2	1	2				3					3	2	1
CO5	3	3	3				3					3	3	3
CO6	3	3	3				3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Stepper Motors

Classification of stepper motors – Hybrid and Variable Reluctance Motor (VRM) -Construction and principle of hybrid type synchronous stepper motor – Different configuration for switching the phase windings control circuits for stepper motors – Open loop and closed loop control of 2-phase hybrid stepping motor.

Construction and principle of operation of Variable Reluctance Motor (VRM) – Single stack and multiple stacks.

Open loop control of 3-phase VR Stepper Motor- Applications

12 Hours

Unit II

Switched Reluctance Motors

Construction – 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

12 Hours

Unit III

Square wave Permanent Magnet Brushless DC Motor

Types of constructions – Surface mounted and interior type permanent magnet – Principle of operation of BLDC motor. Torque and EMF equations – Torque speed characteristics – Performance and efficiency- square wave brushless motors with 120^0 and 180^0 magnetic areas commutation.

Applications of BLDC motor

12 Hours

Unit IV

Sine wave Permanent Magnet Brushless DC Motor

Torque and EMF equations – Phasor Diagram – Circle diagram – Torque/speed characteristics – Comparison between square wave and sine wave permanent magnet motors

Other Special Machines

Construction–Principle of operation and Characteristics of universal motor, AC series motor, Hysteresis motor, Linear Induction motor, Reluctance motor- Applications.

Applications of PMSM

12 Hours

Total:48 Hours

Textbook (s)

1. E. G. Janardhanan, "*Special Electrical Machines*", PHI Learning Private Limited, 1st Edition, 2014.
2. K. Venkataratnam, *"Special Electrical Machines"*, Universities Press (India) Private Limited, 1st Edition, 2009.
3. T. J. E. Miller, *"Brushless Permanent magnet and reluctance motor drives"*, Oxford Science Publications 1st Edition, 1989.

Reference (s)

1. R. Srinivasan, "*Special Electrical Machines*", Lakshmi Publications, 1st Edition, 2018.
2. Theodore Wildi, '*Electric Machines, Drives and Power Systems*', Pearson Education, 6th Edition, 2013
3. Cyril G. Veinott and Joseph E. Martin, "*Fractional and Subfractional Horse-power Electric Motors"*, McGraw Hill Higher Education, 4th Edition, 1986

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/ Assignment Examination (%)
Remember	20	20	---
Understand	50	50	---
Apply	---	---	---
Analyze	30	30	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define detent torque.
2. What are the advantages of switched reluctance motor?
3. Why PMBLDC motor is called as electronically commutated motor?
4. What is the reluctance torque in reluctance motor?

Understand

1. Explain the modes of operation of variable reluctance stepper motor.
2. Explain with neat sketch construction & working of SRM.
3. Drive the expressions for the emf and torque of a PMBLDC motor.
4. Explain the construction & operation of universal motor.

Analyze

1. Analyze the closed loop control scheme of a permanent magnet brushless dc motor drive with a suitable schematic diagram.
2. Discuss the type of control strategy used for different regions of the SRM curves.
3. Describe the hysteresis type and PWM type current regulator for one phase of a SRM.
4. The main functional units in the steel plant are depicted below.
   Blast furnace (BF)
   Steel melt shop (SMS)
   Rolling mill
   (i) To transport coal/ raw materials over conveyor belt to blast furnace (BF). The molten steel is then transferred to steel melt shop (SMS) in wagons. The conveyor belt operates at a variable load at constant speed. Suggest a suitable special machine for conveyor belt system and justify your answer.

   (ii) The molten metal from BF which is received by wagon is lifted by electrically operated trolley EOT crane. The entire working of the SMS plant is based on the operation of the EOT crane which is used to lift and tilt the ladle (bucket) containing molten metal into the heating furnace. The weight of the molten metals will be in tons and the operation must be carried out very slowly to avoid casualties. Suggest a suitable special machine for EOT crane and justify your answer.

   (For Open Book Examination and not for semester end examination)

5. In hospital there is a ICU section and Laboratory section and general ward, in each section there are some conditions need to follow.

(i) In ICU section, for continuous monitoring of the patient there should be motor should be to record the continues pulse of the patient. A specific motor should not produce any noise and mechanical vibrations. Size of the motor should be small and need to consume less power. Suggest a suitable special machine for conveyor belt system and justify your answer.

(ii) In laboratory section medical imaging machinery need to be there, there is no condition for noise and mechanical vibrations. Speed of the machine can be low but need to have high precision. Suggest a suitable special machine for conveyor belt system and justify your answer.

(For Open Book Examination and not for semester end examination)

23EE507 Power Electronics and Drives Lab

0 0 3 1.5

Course Outcomes

1. Demonstrate the characteristics of semiconductor switching devices
2. Analyze the various firing schemes applied to SCR
3. Inspect the forced commutation methods used in Choppers
4. Demonstrate the performance of various types of power electronic converters with R and RL loads
5. Demonstrate the performance of AC-DC / DC-DC converters fed DC drives
6. Show the performance of DC-AC converter fed induction motor drive

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2				2			3	2	1
CO2	3	3	3	3	3				3			3	3	3
CO3	3	3	3	3	3				3			3	3	3
CO4	2	1	2	1	2				2			3	2	1
CO5	2	1	2	1	2				2			3	2	1
CO6	2	1	2	1	2				2			3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

List of Experiments
(Any 10 Experiments)

1. Static V-I characteristics of SCR
2. Static characteristics of MOSFET & IGBT
3. Gate firing circuits for SCR
4. Single Phase AC Voltage Controller with R and RL Loads
5. Single Phase fully controlled bridge converter with R and RL loads
6. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
7. Single Phase Parallel inverter with R and RL loads
8. Single Phase cyclo-converter with R and RL loads
9. Single Phase Half controlled converter with R and RL load
10. Single Phase series inverter with R and RL loads.
11. Speed control of DC motor using Buck-Boost regulator
12. Design of Buck converter
13. Performance & speed control of DC shunt motor using 3-phase semi converter.
14. Performance & speed control of DC shunt motor using 3-phase full converter.
15. Four quadrant chopper fed DC drive.
16. dsPIC microcontroller-based speed control of three phase Induction Motor

List of Augmented Experiments[1]

1. Simulation of single-phase AC voltage controller for different loads using PSPICE/MATLAB
2. Simulation of a single phase fully controlled converter for RLE load using PSPICE/MATLAB
3. Simulation of converter fed DC Motor in closed loop speed control
4. Simulation of PWM inverter using MATLAB/Simulink
5. Simulation of Buck converter and its analysis using open loop and closed controllers
6. PWM pulse generation using low-cost PIC /Arduino controller for three phase inverters

Reading Material (s)

1. M. H. Rashid, "*Power Electronics: Circuits, Devices and Applications*", Prentice Hall of India, 4th Edition, 2017
2. P.S. Bhimbra, "*Power Electronics*", Khanna Publishers, 5th Edition, 2018.
3. M.D. Singh & K.B. Kanchandhani, "*Power Electronics*", Tata Mc Graw Hill Publishing Company, 2nd Edition, 2017.

[1]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

23TPX01 Term Paper

0 0 3 1.5

Course Outcomes

1. Interpret the literature to link the earlier research with the contemporary technologies
2. Communicate effectively as an individual to present ideas clearly and coherently
3. Review the research findings and its correlation to the latest applications
4. Prepare documents and present the concepts clearly and coherently
5. Inculcate the spirit of enquiry for self-learning
6. Identify interdisciplinary oriented topics

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		3	2	3		3	2	3		3		2
CO2	2	2		3	3	3		2	3	3		3		2
CO3	3	3		3	2	3		3	2	3		3		2
CO4	3	3		3	2	3		3	3	3		3		2
CO5	2	2		3	3	3		2	2	3		3		2
CO6	3	2		3	1	3		3	3	3		3		2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

23ESX02 Employability Skills II

1 1 1 0

Course Outcomes

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1	1	1	1			2	3		3	1	
CO2	1		1	1	1	1			2	3		3	1	
CO3	1		1	1	1	1			2	2		3	1	
CO4	2		2	2	2	2			3	1		3	1	
CO5	3		2	2	2	2			3	1		3	2	
CO6	2		2	2	3	3			3	1		3	3	

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

PART-A

Soft Skills

Communication Skills, Confidence and Quantitative Aptitude

Introduction to Campus Placements: Stages of Campus Placement, Skills assessed in Campus Placements & How to get ready?

Motivational Talk on Positive Thinking: Beliefs, Thoughts, Actions, Habits & Results (Success)

Resume Preparation: Resume? Templates? Mistakes to be avoided in a Resume, Steps to be followed in preparing it.(with examples)

Group Discussions (Recap): GD? Stages of a GD, Skills assessed in a GD, Blunders to be avoided, How to excel in a GD? (through Practice Sessions)

Psychometric Tests: Definition, Types of Psychometric Tests: Numerical Computation, Data Interpretation, Verbal Comprehension, Verbal Critical Reasoning and Personality Questionnaires

Exercises related to Communication: Story Writing, TAT etc .

7 Hours

PART-B

Aptitude Skills

Quantitative Aptitude

Square &Cube roots, Partnership, Logarithms, Progressions, Mensuration, Data Sufficiency

8 Hours

PART-C

Domain Specific Knowledge

Programmable logic controllers -3

i. Implementation of Arithmetic instructions
ii. Implementation of X-NOR gate using basic logic gates in PLC
iii. Implementation of on-delay timer
iv. Implementation of off-delay timer
v. Implementation of direct on line (DOL) starter

15 Hours

Total: 30 Hours

Text Books (s)

1. Frederick D. Hackworth and John R. Hackworth, *Programmable Logic Controllers: Programming Methods and Applications*, Pearson India; 1st edition, 2003.
2. Frank Petruzella, *Programmable Logic Controllers*, Tata Mc-Grawhill, 3rd Edition, 2011.

Reference (s)

1. Gary Dunning, Thomson Delmar, "*Programmable Logic Controller*", Cengage Learning, 3rd Edition, 2005.
2. W. Bolton, "*Programmable Logic Controllers*", Newnes – Elsevier, 2015.

23SIX01 Summer Internship I

0 0 0 1.5

Course Outcomes

1. Demonstrate communication skills to meet the requirement of industry
2. Develop logical thinking and analytical skills to thrive in competitive examinations
3. Use mathematical concepts to solve technical quizzes
4. Develop technical skills to work out real time problems
5. Develop algorithms for different applications
6. Solve industry defined problems using appropriate programming skills

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2	3	1	3	3	3	1	3	3	1
CO2	3	3	3	3	2	2	1	3	3	1	1	3	3	2
CO3	3	2	3	2	2	1	1	3	2	3	1	2	3	1
CO4	3	3	3	3	3	3	2	3	3	3	1	3	3	2
CO5	3	3	3	3	3	3	3	3	3	3	2	3	3	2
CO6	3	3	3	3	3	3	3	2	3	3	3	3	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

23HSX10 Engineering Economics and Project Management

3 0 0 3

Course Outcomes

1. Illustrate the principles of engineering economics
2. Demonstrate Cost-Volume-Profit (CVP) analysis in business decision making
3. Implement the financial statements for measuring financial performance of a firm
4. Evaluate investment proposals through various capital budgeting methods
5. Summarize the key issues of organization, management and administration
6. Determine the project cost estimates and plan future activities

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2		2	2	2	2	2	3	2		
CO2	2	1	2	2		2	2	2	2	2	3	2		
CO3	2	1	2	2		2	2	2	2	2	3	2		
CO4	3	3	2	2		2	2	2	2	2	3	2		
CO5	2	1	2	2		2	2	2	2	2	3	2		
CO6	3	1	2	2		2	2	2	2	2	3	2		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Engineering Economics - Demand Forecasting & Cost Analysis

Concept of Engineering Economics – Types of efficiency – Managerial Economics Nature and Scope – Law of Demand – Types of Elasticity of demand.

Demand Forecasting & Cost Analysis: Demand Forecasting: Meaning, Factors Governing Demand Forecasting, Methods of Demand Forecasting (Survey and Statistical Methods) – Cost Analysis: Basic Cost Concepts, Break Even Analysis.

Factors affecting the elasticity of demand – Supply and law of Supply

11 Hours

Unit II

Market Structures - Financial Statements & Ratio Analysis

Different type of Markets Structures – Features – Price Out-put determination under Perfect Competition and Monopoly

Financial Statements & Ratio Analysis: Introduction to Financial Accounting – Double entry system – Journal – Ledger – Trail Balance – Final Accounts (with simple adjustments) – Financial Analysis through Ratios: Interpretation of Liquidity Ratios (Current Ratio and quick ratio), Activity Ratios (Inventory turnover ratio and Debtor Turnover ratio, Creditors Turnover Ratio, Capital Turnover Ratio), Solvency Ratios (Debt- Equity ratio, Interest Coverage ratio), and Profitability ratios (Gross Profit Ratio, Net Profit ratio, Operating Ratio, P/E Ratio and EPS).

Price output determination under Monopolistic markets, Accounting concepts and conventions

3 Hours

Unit III

Investment Decisions and Fundamentals of Management

Time Value of Money – Capital Budgeting: Meaning, Need and Techniques of Capital Budgeting

Introduction to Management: Nature – Importance – Classical Theories of Management: F.W.Taylor's and Henri Fayol's Theory – Functions and Levels of Management – Decision Making Process – Inventory Control, Objectives, Functions – Analysis of Inventory – EOQ.

Maslow & Douglas McGregor theories of Management, ABC Analysis

11 Hours

Unit IV

Project Management

Introduction – Project Life Cycle and its Phases – Project Selection Methods and Criteria – Technical Feasibility – Project Control and Scheduling through Networks – Probabilistic Models of Networks – Time-Cost Relationship (Crashing) – Human Aspects in Project Management: Form of Project Organization – Role & Traits of Project Manager.

Sources of Long-term and Short-term Project Finance

13 Hours

Total: 48 Hours

Textbook (s)

1. Pravin Kumar, "*Fundamentals of Engineering Economics"*, Wiley India Pvt. Ltd., 2nd Edition, 2015
2. Rajeev M Gupta*, "Project Management"*, Prentice Hall of India, 2nd Edition, 2014

Reference (s)

1. Panneer Selvam. R, "*Engineering economics"*, Prentice Hall of India, 2nd Edition, 2013
2. R.B.Khanna, "*Project Management"*, Prentice Hall of India, 1st Edition, 2011
3. R. Panneer Selvam & P.Senthil Kumar, "*Project Management"*, Prentice Hall of India, 1st Edition, 2010
4. A. Aryasri, "*Management Science"*, Tata McGraw Hill, 4th Edition, 2014
5. A. Aryasri, "*Managerial Economics and Financial Analysis"*, Tata McGraw Hill, 4th Edition, 2014
6. Koontz & Weihrich, "*Essentials of Management"*, Tata McGraw Hill, 6th Edition, 2010
7. Chuck Williams and Mukherjee, "*Principle of Management"*, Cengage Learning, 7th Edition, 2013

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book /Assignment Examination (%)
Remember	25	25	---
Understand	35	35	---
Apply	40	40	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define Managerial Economics. Explain its nature and scope.
2. Define Production Function? List the various types of production functions
3. Define the meaning of productivity? Explain how productivity can be enhanced in the Indian industries.
4. Define management and its functions
5. List out short-term source of finance and explain briefly
6. Why is it essential to define project life cycle and divide it into various phases?

Understand

1. Summarize engineering economics with suitable examples.
2. Explain different elements of costs used in cost analysis
3. Illustrate the effect of price on demand and supply with the help of a diagram.
4. Explain the features of Perfect Competition
5. Describe the Top level Upper Middle level of management and its functions
6. Explain Price-Output determination under Perfect Competition under Market period

Apply

1. Consider the following data of company for the year 2015
   Sales = Rs.2,40.000/-
   Fixed cost = Rs.50,000/-
   Variable cost = Rs.75,000/-
   Find out the followings
   a) Profit b) BEP c) Margin of safety
2. The following trial balance of Mr. Ramesh, prepare trading, profit & loss A/c for the year ended 31.12.2018 and balance sheet as on that date.

Particulars	Debit (Rs.)	Credit (Rs.)
Capital		1,00,000
Drawing	18,000	
Furniture	32,500	
Machinery	15,000	

Bills payable		15,000
Interest paid	900	
Sales		1,00,000
Purchases	75,000	
Opening stock	25,000	
Advertisement	15,000	
Wages	2,000	
Insurance	1,000	
Commission received		4,500
Sundry debtors	28,100	
Cash in hand	20,000	
Sundry creditors		10,000
Interest received		3,000
Total	**2,32,500**	**2,32,500**

Adjustments:

Closing Stock Rs.60,000 b) Outstanding wages Rs.500

3. From the following balances as on the date March 31st, 2014.

Particulars	Amount (Rs.)	Particulars	Amount (Rs.)
10% Debentures	3,00,000	Cash in hand	30,000
6% Long term Loans	50,000	Debtors	15,000
Share capital	2,50,000	Opening stock	50,000
Creditors	1,00,000	Closing stock	40,000
Bill payable	45,000	Gross Profit	20,000
Sales	100000	Building	700000

Calculate: Current Ratio, Debt-equity ratio, Quick ratio, Inventory turnover ratio, Debtors turnover ratio

4. A company requires 40,000 kg of raw materials. The company incurs a handing cost of Rs.360/- plus freight of Rs.390 per order. The incremental carrying cost of inventory of raw material is Rs. 15 per kg. Calculate:
   a) EOQ b) Number of orders per annum c) How frequently should orders be placed
5. The following table gives the activities in a construction project and other related information:

Activity	Immediate Predecessors	t_0	t_m	t_p
A	-	1	9	11
B	-	5	6	7
C	A	5	7	9
D	A,B	4	7	10
E	C,D	1	4	7
F	C,D	7	9	11

   a) Draw PERT diagram
   b) Calculate total project duration
   c) Mark the critical path
   d) Find out the S.D and Variance of each activity
6. ABC Ltd., a US based organization, is engaged in manufacturing television screens. It is planning to establish a subsidiary organization in India to manufacture picture tubes. Cost studies produced the following estimates for the Indian subsidiary based on the estimated annual sales of picture tube (Rs.400000/-):

Particulars	Total Annual Cost (Rs.)	Percent of total annual cost that is variable
Materials	1936000	100%
Labour	900000	70%
Overhead	800000	64%
Administration	300000	30%

The Indian production would be sold by manufacturer's representatives who would receive a commission of 8% of the sales. No portion of the parent organizations' expenses is to be allocated to the Indian subsidiary.

Questions:

1. Compute the sale price per picture tube to enable management to realize an estimated 10% profit on sale proceeds in India.
2. Is it feasible for ABC Ltd., to invest in the Indian market by studying the preceding calculation? **(For Open Book Examination and not for semester end examination)**

Analyze

1. From the following cases analysis the situation of price elasticity of product.

Case 1:

Price of product (Rs.)	Quantity of Demand (Units)
100	1000
90	1500

Case 2:

Price of product (Rs.)	Quantity of Demand (Units)
100	1000
70	1100

2. Analyze the attributes to be consider for selection project
3. Differentiate between Perfect Competition & Monopoly Competition
4. Compare significances and limitation of liquidity and solvency ratios.
5. You are given the following information about two companies in the year 2020.

Particular	Company – A	Company – B
Sales	Rs. 50,00,000	Rs. 50,00,000
Fixed Expenses	Rs. 12,00,000	Rs. 17,00,000
Variable Expenses	Rs. 35,00,000	Rs. 30,00,000

A friend seeks your advices as to which company's shares be should purchase. Assuming the capital invested is equal for the two companies, state the advice that you will give.

6. A private school is considering the purchase a school bus to transport students to school. The initial cost of the bus is Rs.600,000. The life of bus is estimated to be five years, after the life time the vehicles would have to be scrapped with no salvage value. The school's management team has derived the following estimates for annual revenues and cost for the next five years.

Year	Annual Revenue	Diver Cost	Repairs & maintenance	Other costs	Annual depreciation
1	330000	33,000	8,000	130000	120000
2	330000	35,000	13,000	135000	120000
3	350000	36,000	15,000	140000	120000
4	380000	38,000	16,000	136000	120000
5	400000	40,000	18,000	142000	120000

The buses would be purchased at the beginning of the project (i.e., in Year 0) and all revenues and expenditures shown in the table above would be incurred at the end of each relevant year. A business consultant has advised management that they should use a cost of capital of 10% to evaluate this project.

Questions:

1. Attributes to be involved to estimate the net cash flow for each year in this project.
2. Justify the steps involved in the calculation process of net present cash flows above the project investment. **(For Open Book Examination and not for semester end examination)**

23EE602 Power System Analysis and Control

3 0 0 3

Course Outcomes

1. Illustrate the per-unit representation for given power system network
2. Analyze power system behavior under short circuit conditions
3. Make use of load flow and stability studies in power system networks
4. Model load frequency control components
5. Analyze the various economic aspects of power plant operations
6. Examine the behavior of power system for change in load demand

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2			2	2					3	2	2
CO2	3	3	3			3	2					3	3	2
CO3	3	2	3			3	2					3	3	2
CO4	3	3	3			3	2					3	3	2
CO5	3	3	3			3	2					3	3	2
CO6	3	3	3			3	2					3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit – I

Per-unit Representation and Short Circuit Analysis

Per-unit System representation of a given power system network, Per-unit equivalent reactance diagram Symmetrical fault Analysis: Short Circuit Current and MVA Calculations. Symmetrical Component Theory: Symmetrical Component Transformation, Sequence Networks. Unsymmetrical Fault Analysis: LG, LL, LLG faults without fault impedance

Unsymmetrical Fault Analysis: LG, LL, LLG faults with fault impedance

12 Hours

Unit –II

Power Flow studies and stability

Power flow problem – significance, classification of buses, Formation of Y_{bus} using direct inspection method, Derivation of Static load flow equations, Load flow solutions using Gauss Seidel Method, Acceleration Factor, Newton Raphson Method in Rectangular and Polar Co-ordinates, Comparison of different load flow methods. (Only derivative approach)

Stability: Classification of power system stability, Swing equation, equal area criterion and its applications, methods to improve stability

Decoupled and Fast decoupled load flow method

12 Hours

Unit – III

Economic operation of power system

Input-output characteristics, heat-rate curve, incremental fuel cost, incremental production cost, optimal generation allocation with and without transmission line losses, loss coefficients, hydro-thermal scheduling-long term and short term, unit commitment-priority list method

Dynamic programming method

12 Hours

Unit – IV

Load Frequency Control

Necessity of keeping voltage and frequency constant, Modeling of Speed governing system, Turbine, Generator and load systems, complete block diagram of an isolated power system, Control area, Single area control -Steady state analysis, Dynamic response -uncontrolled and controlled cases.

Load frequency and economic dispatch control- Load frequency control of two area system – Steady state analysis, Dynamic response -uncontrolled and controlled cases, tie-line bias control.

Performance Index and optimal load frequency control

12 Hours

Total: 48 Hours

Textbook (s)

1. I.J. Nagrath & D.P. Kothari, "*Modern Power System Analysis*", Tata McGraw-Hill, 4th Edition, 2013.
2. C.L. Wadhwa, "*Electrical Power Systems*", New Age International Publishers, 7th Edition, 2017.
3. P.Kundur, *"Power System Stability and Control",* McGraw Hill Inc, 2nd Edition**,** 2005
4. Allen J Wood, Bruce F Wollenberg, Gerald B Sheble, "*Power Generation, Operation and Control*", Wiley India, 3rd Edition, 2013.

Reference (s)

1. John J. Grainger, William D. Stevenson, Gary W. Chang, "*Power System Analysis*", McGraw Hill, 2016.
2. Hadi Saadat, "*Power System Analysis*", McGraw Hill, 3rd edition, 2011.
3. N V Ramana, "*Power System Operation and Control*", Pearson Education India, 2010.
4. M.A. Pai, "*Computer Techniques in Power System Analysis*", TMH Publications, 2nd Edition, 2000.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book /Assignment Examination (%)
Remember	15	15	---
Understand	20	25	---
Apply	35	30	---
Analyze	30	30	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define per-unit value.
2. List the advantages of per-unit system.
3. Define acceleration factor
4. Define control area

Understand

1. Explain the necessity of slack bus.
2. Represent the equation for transformation base kV on LT side to HT side of a transformer and vice-versa.
3. Classify buses in the load flow study
4. Outline single area load frequency control

Apply

1. A 50Hz, 13.2kV, 30MVA alternator has X1=X2=30% and X0=18% and the neutral is grounded through a reactor of 0.5 ohm. Determine the initial symmetrical RMS current in the ground reactor when a double line o ground fault occurs at the generator terminals at the time when the generator voltage was 22kV.
2. Find the expression for fault current for line-to-line fault without fault impedance using symmetrical components method
3. Demonstrate operation of single area load frequency control
4. Describe the Economic dispatch control and Load frequency control

Analyze

1. Distinguish different load flow method for power system study.
2. Contrast with and without PI control operation of LFC
3. Analyze the concept of two area load frequency control
4. Figure 1 shows a load flow situation. There are two generators, one generating at unity power factor, the other under voltage control. The generator on bus 1 is producing two per-unit real power and

zero reactive power. The generator on bus 3 is providing one per-unit real power and is controlled to unity voltage. There are loads of two per-unit on bus 2 and one per-unit on bus 5. Bus 4 is the 'swing bus', with voltage magnitude of one and angle of zero.

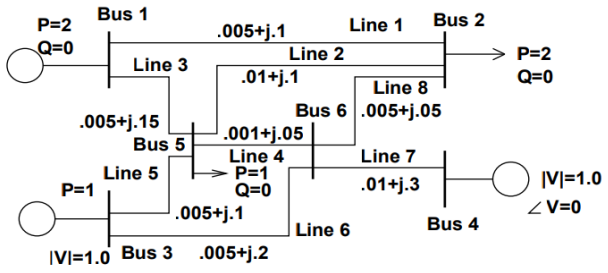


Figure 1: Load Flow Problem

a) For this problem, calculate the bus voltages and line currents. In your answer, generate a list of bus voltage magnitudes and angles and a list of line currents.

b) Also, estimate the reactive power supplied by the generator at Bus 3 and the real and reactive power supplied by the swing bus. To assist, you will need to fill in the bus incidence matrix.

c) You will note that the voltages at the various buses are actually not very good. It would be good if we could get the voltage magnitudes to be within ±5% of one per-unit. You should be able to accomplish this by injecting some reactive power into the system at selected points. Figure out where and how much reactive power to inject and show, with a run of the program, that this does correct the voltage profile to within the required tolerance.**(For Open Book Examination and not for semester end examination)**

5. Re-draw the system diagram (figure 2) with all impedances and loads translated to per-unit. Assume that the transformers between 69 and 161 kV, buses 15 and 16 at one substation and between buses 9 and 17 at another substation are rated at 150 MVA and that their voltage ratings correspond with the nominal system voltages. You may represent them as purely reactive with x_t = 8% on their own base. For your per-unit normalization use a system base of 100 MVA and the nominal system voltages (161 and 69 kV). Note, of course, that power called out at each bus is MW+jMVAR and that voltage are line-line, RMS. **(For Open Book Examination and not for semester end examination)**

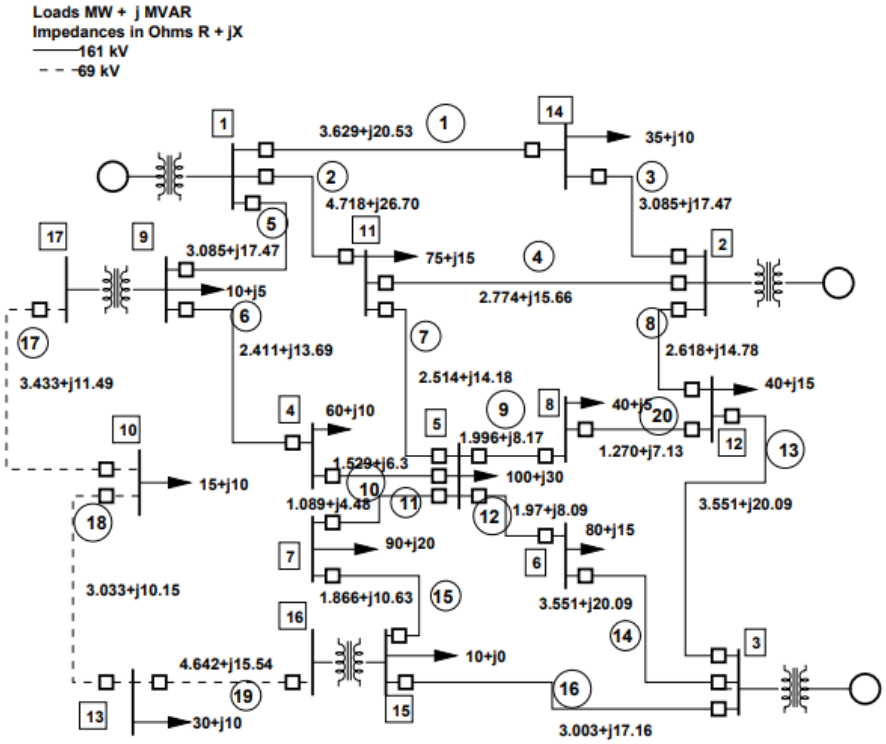


Figure 2: Example Power System

23EE603 Utilization of Electrical Energy

3 0 0 3

Course Outcomes

1. Identify suitable motor based on application
2. Summarize electric heating and welding methods
3. Design interior and exterior lighting systems
4. Apply electrolytic & electrolysis process in chemical manufacturing
5. Summarize the principles of refrigeration and air-conditioning
6. Analyze the performance of traction systems

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3			3	3					3	2	
CO2	2	3	2			2	3					2	2	
CO3	3	3	3			3	3					3	2	
CO4	3	2	2			3	3					3	3	
CO5	2	2	2			2	3					2	2	
CO6	3	3	2			3	3					3	3	

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Electric Drives, Heating and Welding

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, Particular applications of electric drives, Types of industrial loads, continuous, Intermittent and variable loads, load Equalization.

Advantages and methods of electric heating-resistance heating, induction heating and dielectric heating

Electric welding-resistance and arc welding, comparison between A.C. and D.C. Welding

Electric braking-Plugging, Rheostat braking, Regenerative braking

11 Hours

Unit II

Illumination

Introduction, terms used in illumination, laws of illumination, polar curves, sources of light. Basic principles of light control, CFL & LED lighting-phenomena, construction and working, flood lighting, Types and design of lighting, measurement of illumination- photometry, integrating sphere.

tungsten filament lamps and fluorescent tubes, IS 6665, 3646, 2440 codes

13 Hours

Unit III

Electrolytic Processes, Refrigeration and Air Conditioning

Need of electro-deposition, Laws of electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing, buffing, Equipment and accessories for electroplating, Factors affecting electro-deposition, Principle of galvanizing and its applications, Principles of anodising and its applications, Electroplating on non-conducting materials, Manufacture of chemicals by electrolytic & electrolysis process.

Principle of air conditioning, vapor pressure, refrigeration cycle, Description of Electrical circuit used in refrigerator, air-conditioner and water cooler

Eco-friendly refrigerants, BEE ratings, ISEER value

11 Hours

Unit IV

Electric Traction

System of Traction - Diesel & electric traction – Need for 25kV single phase AC traction in India, block diagrams of locomotives employing DC and AC drives, locomotive equipment – pantograph, transformer, rectifier, inverter, protective devices, Traction Mechanics: Mechanics of traction movement - speed-time curves for different services - trapezoidal and quadrilateral speed-time curves - tractive effort requirement at driving wheels and for propulsion of train - power - specific energy consumption –factors effecting specific energy consumption–Dead, accelerating and adhesive weights, Coefficient of adhesion

Track electrification - DC, AC & Composite systems

13 Hours

Total: 48 Hours

Textbook (s)

1. *Art and Science of Utilization of Electrical Energy* by H Partap, Dhanpat Rai & Sons, 2nd edition, 2017
2. *Utilization of Electrical Energy and Traction* by J.B. Gupta, Rajeev Manglik, Rohit Manglik, Kataria Publications, 1st edition, 2013
3. *A Text Book of Electrical Power* by Dr. S.L Uppal, Khanna Publications, 1st edition, 2014

Reference (s)

1. *Modern Electric Traction* by H Partap, Dhanpat Rai & Sons, 2nd edition, 2017
2. *Generation, Distribution and Utilization of Electrical Energy* by CL Wadhwa, New Age International Publishers, 3rd edition, 2015.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book/Assignment examination (%)
Remember	25	25	---
Understand	50	50	---
Apply	25	25	50
Analyze	---	25	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define adhesive weight
2. Give the expression for distance covered by a train for a specific run assuming quadrilateral speed time curve.

Understand

1. Derive an expression for the time-dependent temperature as the electrical apparatus cools, in terms of the cooling time constant.
2. Explain the Law of Inverse Squares w.r.t. illumination.

Apply

1. A hall of 30m×13m with ceiling height of 5m is to be provided with general illumination of 120lux. The coefficient of utilization is 0.5 and depreciation factor is 1.4. Determine the total wattage, number of fluorescent lamps required. Luminous efficiency of 80W lamp is 40lumen/watt. Show disposition of lamps with sketch. **(For Open Book Examination)**
2. An electric train accelerates uniformly from rest to a speed of 48 kmph in 24 seconds. It then coasts for 69 seconds against a constant resistance of 50 N/tonne and is braked to rest at 3.3 kmphps in 11 seconds. Calculate (i) coasting retardation (ii) V2 (iii) total distance (iv) schedule speed, if the station stops are 20 seconds duration. What would be the effect on schedule speed of reducing the station stop to 15 seconds duration, other conditions remaining same? Allow 10% for rotational inertia.

Analyze

1. Identify a suitable motor for suburban system. Justify the selection.
2. Analyze the need for adopting 25kV single phase traction system in India
3. Visakhapatnam, an upcoming smart city in India, proposes to introduce a mass rapid rail transport system keeping in view its future transportation needs. The administrative body decides upon to adopt a 25kV single phase overhead AC suburban service system for the city. Analyze the reasons for this mode of traction over other alternatives available. Also, list the pros and cons of this selection. **(For Open Book Examination)**

23EEC12 Electric Vehicle Drive Train Systems

3 0 2 4

Course Outcomes

1. Outline the performance of various EV drive train systems
2. Analyze the performance of various propulsion drives for Electric Vehicle
3. Contrast the performance of BLDC and PMSM motors in EV drive train systems
4. Analyze the performance of Series-Parallel Electric drive train system
5. Analyze the performance of Fuel cell EV drive train system
6. Contrast the Series-Parallel and Fuel cell drive train performance

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	2	2	2	2	2		1			3	2	2
CO2		3	3	3	3	3	3		3			3	3	3
CO3		2	2	2	2	2	2		2			3	3	2
CO4		3	3	3	3	3	3		3			3	3	3
CO5		3	3	3	3	3	3		3			3	3	3
CO6		2	2	2	2	2	2		2			3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

EV Drive Train

Introduction to Configurations and Performance of Electric Vehicles, Traction Motor characteristics, Tractive effort and Transmission Requirement, Vehicle Performance, Tractive Effort in Normal Driving, Energy Consumption.
Importance of Different Transportation Development Strategies to Future Oil Supply

Practical Component

1. Generate electrical characteristic curves of a series motor and a shunt motor.
2. Compute the cumulative tractive force necessary for an electric vehicle throughout a provided drive cycle.
3. Based on driving cycle and vehicle dynamics, analyse motor and battery power requirements for vehicle propulsion.
4. Calculate the total distance travelled in one drive cycle & Energy used per km.

10+8 Hours

Unit II

Propulsion System

Introduction to DC motor drives, Induction motor drives- V/F, Field Oriented Control, Permanent Magnetic Brush-Less DC Motor Drives and Permanent Magnetic Synchronous Motor Drives- Modeling, Analysis and Control.
Drive Train with Floating-Stator Motor
HEV to PHEV Conversions

Practical Component

1. Simulation of BLDC drive system
2. Simulation of PMSM drive system
3. Speed Control of BLDC using DSP-2407
4. Speed Control of PMSM using DSP-2407

13+8 Hours

Unit III

SHEV& PHEV Drive Train Design

SHEV & PHEV -operation Patterns, Control Strategies, Max. SOC of PPS & Engine Turn-On/Turn-Off, Drive Train Parameters.

Practical Component

1. Simulate the behaviour and performance of an electric vehicle.
2. Simulate the various modes of operations in a Series Hybrid Electric Vehicle.
3. Simulate the various modes of operations in a Parallel Hybrid Electric Vehicle.
4. Simulate and evaluate the thermostat control strategy for engine activation (on-off) in series hybrid and parallel hybrid electric vehicles

12+8 Hours

Unit IV

Fuel Cell HEV Drive Train Design

Operating Principles of Fuel Cells, Electrode Potential and Current–Voltage Curve, Fuel Cell System Characteristics, Fuel cell drive train Configuration, Control Strategy, Parametric Design.

Non-hydrogen Fuel Cells

Practical Component

1. Modelling and Simulation of Fuel cell
2. Controller design for Fuel Cell System
3. Simulate the various modes of operations in a Hybrid Fuel Cell Electric Vehicle
4. Write a program on fuel cell's power generation based on hydrogen flow rate

13+8 Hours

Total: 48+32=80 Hours

Textbook (s)

1. Chris Mi, Abul Masrur and David Wenzhong Gao, "*Hybrid Electric Vehicles-Principles and Applications with Practical Perspectives*", A John Wiley & Sons, Ltd., Publication, 1st edition, 2011.
5. James Larminie, John Lowry, "*Electric Vehicle Technology Explained"*, Wiley, 2003.
6. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi "*Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*', CRC Press, 2005.

Reference (s)

1. Rolf Isermann, "*Engine Modeling and Control - Modeling and Electronic Management of Internal Combustion Engines*", Springer Verlag, 2014.
2. William, B. Ribbens, "*Understanding Automotive electronics*", Butterworth Heinemann, 2017.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	10	10	---
Understand	20	10	---
Apply	30	40	50
Analyze	40	40	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define tractive effort
2. List various electrical braking methods
3. List the various factors effecting fuel economy in PHEV's
4. List various fuel cell technologies

Understand

1. Outline the Performance of Electric Vehicles
2. Explain the Torque-Coupling Operating Mode in HEV's
3. Outline the Power Management of PHEVs
4. Illustrate the Fuel Cell System Characteristics

Apply

1. Identify the transmission requirement in EV's
2. Develop the Control Strategy in HEV's
3. Identify the Component Sizing of EREVs
4. Develop the Power Design of the Fuel Cell System

Analyze

1. Analyze the various traction motor characteristics
2. Analyze the performance of Series Hybrid Electric Drive Trains and Parallel Hybrid Electric Drive Trains
3. Examine the Power Management of PHEVs
4. Analyze the various Fuel Cell Technologies

23EEC22 Power Electronic Applications to Green Energy Systems

3 0 2 4

Course Outcomes

1. Analyze the performance of DC-DC converter
2. Demonstrate the working and performance of DC-DC converter
3. Design a suitable converter for solar PV system
4. Analyze the performance of the inverter
5. Demonstrate the working and performance of the inverter
6. Design a suitable converter for wind energy system

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	3	3	3	3	3		3			3	3	3
CO2		2	2	2	2	2	2		2			3	2	2
CO3		3	3	3	3	3	3		3			3	3	3
CO4		3	3	3	3	3	3		3			3	3	2
CO5		2	2	2	2	2	2		2			3	2	2
CO6		3	3	3	3	3	3		3			3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-I

DC-DC Converters 1 for solar energy system

The Role of Power Electronics in Renewable Energy Systems, General Scheme for a Solar PV System, Utility-scale PV Power Plants & stand-alone PV systems, Topologies of DC-DC converters, Unidirectional DC-DC converter, Bidirectional DC-DC converter, non-isolated bidirectional DC-DC converters, Isolated bidirectional DC-DC converters.

Double-input pulse width modulation DC-DC converter

Practical Component

1. Simulation of Uni-directional Buck DC-DC converter
2. Simulation of Uni-directional Boost DC-DC converter
3. Simulation of Uni-directional Buck-Boost DC-DC converter
4. Simulation of closed loop control in Uni-directional Boost DC-DC converter

12+8 Hours

Unit-II

DC-DC Converters 2 for solar energy system

Half-bridge LLC resonant converter, Benefits of resonant converters, Emerging DC-DC converter topologies, SEPIC converter, Luo converter, Soft-switching converter, Series charge controller, Shunt charge controller.

Integrated SEPIC-Cuk converter

Practical Component

1. Simulation of Bi-directional DC-DC converter
2. Simulation of Uni-directional SEPIC DC-DC converter
3. Simulation of Uni-directional LUO DC-DC converter
4. Simulation of Uni-directional CUK DC-DC converter

12+8 Hours

Unit-III

Multilevel converters and configurations for wind energy system

Multilevel converter topologies, Diode-clamped inverter, Capacitor-clamped inverter, Cascaded H-bridge inverter, Flying capacitor multilevel inverter.

Comparisons between the three-Level NPC and NPP Inverters

Practical Component

1. Simulation of 1-ϕ, 2 level H bridge Inverter
2. Simulation of 1-ϕ, 3 level H bridge Inverter
3. Simulation of 1-ϕ, diode clamped Multi level Inverter
4. Simulation of 3-ϕ, diode clamped Multi level Inverter

12+8 Hours

Unit-IV

Modulation techniques for multilevel converters in wind energy system

Modulation Methods for Multilevel Power Converters, Carrier ‐ Based Modulation Techniques, Level ‐ shifted PWM Method, Phase ‐ shifted PWM Method, Hybrid PWM Methods, Space ‐ vector based modulation methods, Grid ‐ connected Multilevel Converters for the Integration of Renewable Energy Sources.

Converters for tidal energy systems

Practical Component

1. Simulation of 1-ϕ, flying capacitor Multi level Inverter
2. Simulation of 3-ϕ, flying capacitor Multi level Inverter
3. Simulation of 1-ϕ, cascaded H-bridge Multi level Inverter
4. Simulation of five-level Modular Multi-level inverter

12+8 Hours

Total: 48+32=80 Hours

Text Book(s)

1. Bimal K Bose, "*Power Electronics in Renewable Energy Systems and Smart Grid*", IEEE Press and John Wiley & Sons, 2019.
2. L. Ashok Kumar, S. Albert alexander, M. Rajendran, "*Power Electronic Converters for Solar Photovoltaic Systems*", Academic Press, 2021.

Reference Book(s)

1. Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, "*Power Electronics for Renewable Energy Systems*, Transportation and Industrial Applications", IEEE Press and John Wiley & Sons, 2014.
2. Vahedi, Trabelsi, Mohamed, "*Single-DC-Source Multilevel Inverters*," Springer, 2019.
3. Ersan Kabalci, "*Multilevel Inverters- Control Methods and Advanced Power Electronic Applications*," Academic Press, 2021.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	20	20	---
Understand	50	50	---
Apply	30	30	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two advantages of Luo converter
2. List any two advantages of Resonant converter
3. Select a suitable DC-DC converter for a solar PV system

Understand

1. Explain the operation of Luo converter.
2. Explain the operation and working of Half-bridge LLC resonant converter.
3. Explain the operation and working of Flying capacitor multi-level inverter.

Apply

1. Build a Bi-directional DC-DC converter for islanded solar PV system.
2. Build Luo converter for islanded solar PV system.
3. Develop a Uni-directional converter for islanded solar PV system with.

Analyze

1. Analyze the impact of leakage current on the performance of Modular Multi-level converter.
2. A modular multi-converter is installed on grid integrated wind energy system. One of firing pulse of upper module of a Modular Multi-level converter is disconnected because of loose connection. Now

analyze the performance of the converter under this fault condition. Suggest some suitable approaches to identify the fault.

3. Analyze the working of multilevel inverter under variable load conditions.

23EEC32 Control and Instrumentation of Smart Grid Systems

3 0 2 4

Course Outcomes

1. Summarize the control strategies for AC systems in smart grid
2. Analyze the control strategies for DC systems in smart grid
3. Identify voltage and frequency control schemes for smart grid.
4. Identify the importance of smart instruments and benefits of Smart Grid
5. Outline the smart management systems for Smart Grid
6. Classify smart sensors for PMU and WAMS

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	2	3					3	3	3
CO2	3	3	3	3	2	2	3					3	3	3
CO3	3	3	3	3	3	3	3					3	3	3
CO4	3	3	2	3	3	2	3					3	3	3
CO5	3	3	2	3	3	3	3					3	3	3
CO6	3	3	3	3	3	3	3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Concept Strategies for Smart Grid Systems

Control Strategies for AC and DC Systems **–** Micro-grid Control Hierarchy, Local Control, Secondary Control, Central/Emergency Control, Global Control, Droop Control, Droop Characteristic in Conventional Power Systems, DC Microgrid for a Residential Area, System Configuration and Operation.

Resistive Grid

Practical component:

1. Study the control in an AC microgrid system.
2. Study the control in a DC microgrid system.

12+8 Hours

Unit II

Voltage and frequency control in smart grid

Load frequency control, Voltage Stability Assessment, Concepts on the design of smart grid stabilizers to improve voltage stability, frequency & voltage regulations, and volt-VAR support, Operational aspects of smart grid system, active and reactive power response.

Ancillary Services

Practical Component:

1. Eigen value analysis of single machine infinite bus system.
2. Synchronous generator no load short circuit analysis.
3. Study of voltage stability and obtain PV and QV curves for two bus system.

12+8 Hours

Unit III

Introduction to Instrumentation System in Grid Scenario

Smart devices, Smart Sensors, Data Cataloguing, Data Recording, Data Processing, Application of smart sensors, Grid Management system (block diagram), Battery modeling system (block diagram), Study of accurate prediction using AI techniques.

Need of Smart Instruments: Low Power devices, wired or wireless technology and its Advantages.

Need of High Bandwidth Storage devices in SG

Practical Components:

1. Study of renewable energy data profile and finding the mean.
2. Study of data normalization procedure.
3. Plotting of Renewable energy data and find the maximum and minimum value.

12+8 Hours

Unit IV

Sensors, PMUs and WAMS

Smart Substation: Advanced Magnetic Sensor, Fiber Optic Sensor and its application- phasor measurement units (PMU) - Wide area measurement systems (WAMS)-Concept, architecture, data collection, advanced data processing in smart grids.

Smart Meters

Practical component:

1. Analysis of data conversion and data acquisition
2. Voltage Sensor/ Current sensor in power system during fault analysis
3. Find the resolution and measurements of Digital meter/Digital Instruments for the given specifications

12+8 Hours

Total: 48+32=80 Hours

Textbook (s)

1. H. Bevrani, B. François, T. Ise, "*Microgrid Dynamics and Control*", John Wiley & Sons, 1st Edition, 2017.
2. J. Momoh, "*Smart Grid: Fundamentals of Design and Analysis*," Wiley-IEEE Press, 1st Edition, 2012.
3. Huang, Qi, et al. "*Innovative testing and measurement solutions for smart grid*". John Wiley & Sons, 2015.
4. R. Messina, "*Wide Area Monitoring of Interconnected Power Systems*", IET publisher, 1st Edition, 2018

Reference (s)

1. S. Borlase, "*Smart Grids, Infrastructure, Technology and Solutions*", CRC Press, 1st Edition, 2013.
2. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, "*Smart Grid: Technology and Applications*," John Wiley & Sons, 1st Edition, 2015.
3. Yong Li, D. Yang, Fang Liu, Y. Cao, "*Interconnected Power Systems Wide-Area Dynamic Monitoring and Control Applications*", Springer-Verlag Berlin Heidelberg, 1st Edition, 2016.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	25	25	---
Understand	50	50	---
Apply	25	25	75
Analyze	---	---	25
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define droop control.
2. Recall the role of real and reactive power in smart grid.
3. Mention the use of phasor measurement unit.

Understand

1. Classify local and secondary control.
2. Outline the bottlenecks in smart grid control.
3. Classify the various time frequency representations of signal in smart grids.

Apply

1. Develop the concept of voltage clamo control for dc components in smart grid.
2. Develop a controller for voltage control in smart grid
3. Develop the concept of WAMS in smart grid.
4. Apply the basic concepts how to transfer the normal grid to smart grid and its importance in daily life.

Analyze

1. Examine the characteristics of droop control in conventional power systems.
2. Analyze the controllers suitable for self-healing system.
3. Examine the important aspects of wide area measurement systems.
4. Analyze the Importance of Prediction in Smart grid Architecture.

23EE020 Advanced Control Systems

3 0 2 4

Course Outcomes

1. Apply z-transforms to discrete time systems
2. Develop pulse transfer function for a given discrete time system
3. Examine the controllability, observability and stability of a given system
4. Design state feedback controller/observer for a given system
5. Identify different types of non-linearities
6. Analyze non-linear systems using describing function and phase plane analysis

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3						2	3	2
CO2	3	3	3	2	3	3						2	3	2
CO3	3	3	3	3	3	3						2	3	2
CO4	3	3	3	3	3	3						2	3	2
CO5	3	3	3	3	3	3						2	3	2
CO6	3	3	3	3	3	3						2	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit – I

Fundamentals of Digital control systems and Z-transforms

Fundamentals of Digital Control System: Block diagram of digital control system, Advantages, disadvantages and applications of digital control system, Sampling operations, sampling theorem, Aliasing effect, Zero order hold.

Z–Transforms: Introduction, Properties and theorems of Z-transforms, Inverse Z-transforms, Z-Transform method for solving difference equations, Pulse transfer function, block diagram analysis of sampled-data systems, Pulse transfer function of ZOH.

Examples of digital control systems

Practical Component

1. Determination of Pole-Zero Plot using MATLAB/Scilab
2. Determination of pulse transfer function using MATLAB/Scilab

12 + 8 Hours

Unit – II

Stability Analysis

Mapping between s-plane and the z-plane, Stability Analysis of closed loop systems in the z-plane- Bilinear Transformation, Jury stability test, Lyapunov Stability

Concepts of Controllability and Observability, Tests for controllability and Observability, Duality between controllability and observability, Effect of Pole-zero Cancellation in Transfer Function.

Steady state error analysis of digital control system

Practical Component

1. Analysis of Stability of a given discrete time systems using MATLAB/Scilab
2. Tests for controllability and observability a given discrete time systems using MATLAB/Scilab

12 + 8 Hours

Unit – III

State feedback Controllers and Observers

Design of state feedback controller through pole placement- Ackerman's formula, Effect of dead-beat response

State Observers – Full order observer. Effect of dead-beat response

Reduced order observer

Practical Component

1. Design of full order and reduced order observers a given systems using MATLAB/Scilab
2. Design of state feedback controller through pole placement using MATLAB/Scilab

12 + 8 Hours

Unit – IV

Non-linear Systems

Features of linear and non-linear systems-Common physical non-linearities–Derivation of describing functions for common nonlinearities-Concept of phase portraits–Singular points–Limit cycles–Phase plane analysis of linear and non-linear systems–Isocline method.

Construction of phase portraits

Practical Component

1. Phase plane analysis of a given nonlinear system by analytical method using MATLAB/Scilab
2. Phase plane analysis of a given nonlinear system by Isocline method using MATLAB/Scilab

12 + 8 Hours

Total: 48+32=80 Hours

Text book (s)

1. K. Ogata, "*Discrete-Time Control Systems"* PHI Learning, 2nd Edition, 2008.
2. Katsuhiko Ogata "*Modern Control Engineering*" Prentice Hall of India Pvt. Ltd., 5th Edition, 2011.

Reference (s)

1. B.C. Kuo, "*Digital Control Systems*", Oxford University Press, 2nd Edition, 2007.
2. M. Gopal, "*Modern control system theory"*, New Age International Publishers, 4th Edition, 2003.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	20	20	---
Understand	50	40	---
Apply	30	40	60
Analyze	---	---	40
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define discrete time control system
2. List different types of discrete time systems
3. State Sampling theorem
4. List the properties of state transition matrix
5. Define stability in the sense of Lyapunov

Understand

1. Explain the properties of Z-transform.
2. Formulate the pulse transfer function for ZOH
3. Represent the necessary and sufficient conditions for pole placement
4. Represent the conditions for controllability and observability

Apply

1. Implement pole placement design of continuous time system with a suitable example
2. Demonstrate Jury's stability test for a given discrete time system
3. Compute the impulse response of sampled data system to step and ramp inputs.

Analyze

1. Examine whether the discrete data system

$$x(k+1) = Ax(k) + Bu(k),\ \ y(k) = Cx(k)$$

Where $A = \begin{bmatrix} 0 & -1 \\ 1 & -1 \end{bmatrix}, B = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \& B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ Is (i) State controllable (iii) Observable

2. Consider the following pulse transfer function, $\frac{Y(z)}{U(z)} = \frac{z+0.2}{(z+0.8)(z+0.2)}$. Inspect this system is completely state controllable or not?
3. Contrast briefly about simple degeneracy and full degeneracy
4. A discrete system is described by the difference equation
   $y(k+2)+3y(k+1)+2y(k)=r(k), \quad y(0)=y(1)=0, T=1Sec.$
   Identify a state variable model for the system?

23EE021 Discrete Signal Processing

3 0 2 4

Course Outcomes

1. Classify discrete time signals and systems
2. Apply Discrete Fourier transform and Fast Fourier transform for a given discrete time signal
3. Contrast the signals in time and frequency domain
4. Develop FIR and IIR digital filters for a given application
5. Examine the frequency response characteristics of FIR and IIR digital filters
6. Apply adaptive filters for various applications

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2						2	3	3
CO2	3	3	3	2	3	3						2	3	3
CO3	3	3	3	3	3	3						2	3	3
CO4	3	3	3	3	3	3						2	3	3
CO5	3	3	3	3	3	3						2	3	3
CO6	3	3	3	3	3	3						2	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Introduction to Discrete–Time signals and systems

Classification of discrete-time signals and sequences, properties of discrete time signals and systems, difference equations and their solutions – homogeneous and non-homogeneous equations, Linear and circular convolution, Sampling theorem and aliasing effect.

Concept of z-transforms, Region of Convergence, properties, Inverse z- transform and its application in solving the difference equations.

Analog-to-digital conversion and digital-to-analog conversion techniques

Practical Component

1. Determination of convolution of a given two discrete time signals using MATLAB/ Scilab
2. Determination of frequency response of a given discrete time system using MATLAB/ Scilab
3. Determination of Pole-Zero plot of a given discrete time system using MATLAB/ Scilab

12 +8 Hours

Unit II

Discrete–Time signals in Transform domain

Discrete Fourier Series (DFS), Discrete Fourier transform (DFT), Properties of DFT, Fast Fourier transform (FFT) – butterfly diagrams - Radix-2 decimation in time, Inverse FFT. Quantization effects in the computation of the DFT.

Short-time Fourier transform (s-transform)

Practical Component

1. Computation of DFT using DIT FFT algorithm for a given discrete time signals using MATLAB/ Scilab
2. Computation of IDFT using DIT FFT algorithm for a given discrete time signals using MATLAB/ Scilab

12 + 8 Hours

Unit III

IIR and FIR Digital Filters

IIR Filters: Properties of linear-phase IIR filters, Butterworth and Chebyshev filters, Impulse Invariant transformation, Bilinear transformation

FIR Filters: Characteristics of FIR Digital Filters, Gibbs phenomenon, windowing techniques – rectangular, Hamming, Hanning and Bartlett. Comparison of IIR & FIR filters.

Program to design FIR and IIR filters

Practical Component

1. Design of FIR filter from the given specifications for a particular using MATLAB/ Scilab
2. Design of IIR filter from the given specifications for a particular using MATLAB/ Scilab

12 + 8 Hours

Unit IV

Introduction to Multi-rate Signal Processing

Multi-rate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering.

Program to design adaptive filters

Practical Component

1. Illustration of up-sampling for a given discrete time signal using MATLAB/ Scilab
2. Illustration of down-sampling for a given discrete time signal using MATLAB/ Scilab
3. Design of adaptive filter for a given application using MATLAB/ Scilab

12 + 8 Hours

Total: 48+32=80 Hours

Textbook (s)

1. John G. Proakis, Dimitris, G. Manolakis," *Digital Signal Processing, Principles, Algorithms, and Applications*", Pearson Education / PHI, 4th Edition, 2013.
2. Alan V. Oppenheim, Ronald W. Schafer, "*Digital Signal Processing*", PHI, 4th Edition, 2007

Reference (s)

1. Sanjit K.Mitra, "*Digital Signal Processing*", Tata Mc Graw Hill publishers, 4th Edition, 2013.
2. MH Hayes, "*Digital Signal Processing, Schaum's Outlines*", Tata Mc-Graw Hill, 2nd Edition,2009
3. S. Salivahanan, A. Vallavaraj, "*Digital signal processing*", Tata McGraw-Hill Education, 21st reprint, 2007.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	25	20	---
Understand	45	40	---
Apply	30	40	60
Analyze	---	---	40
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Signal and System
2. List any two advantages of DSP
3. Define Gibb's phenomena
4. Recall the need of Multi rate signal processing
5. List any four differences between FIR and IIR filters

Understand

1. Show that the following systems is time invariant
   (i) $y(n) = x(n) - x(n-1)$
   (ii) $y(n) = nx(n)$
   (iii) $y(n) = e^{x(n)}$
2. Show that the given systems are stable
   (i) $y(n) = \cos(\ x(n))$
   (ii) $y(n) = x(-n-2)$
   (iii) $y(n) = ax^2(n)$
3. Illustrate whether the signal x(n)=sin15πn+ sin√2_n is periodic or not
4. Illustrate windowing techniques to design FIR filters
5. Summarize the need of anti-aliasing filter prior to down sampling in multirate signal processing

Apply

1. Solve for the DFT of a sequence x[n] = {1, 2, 3, 4, 4, 3, 2, 1} using DIT algorithm
2. Solve for the IDFT of the sequence X[k] = {12, 0, 0, 0, 4, 0, 0, 0} using DIF Algorithm
3. Develop a digital butterworth filter to meet the following constraint

   3db ripple in pass band; $0 \leq \omega \leq 0.2\pi$

   25db attenuation in stopband; $0.45\pi \leq \omega \leq \pi$

   by using bilinear transformation and assume sampling period T= 1 sec

Analyze

1. Simplify the analog filter with transfer function $(s+0.1)/(s+0.1)^2+9$, into a digital IIR filter using bilinear transformation. The digital filter should have a resonant frequency of $\omega_r = \pi/4$
2. The specification of the desired LPF is

   $0.8 \leq |H(\omega)| \leq 0.1 \quad 0 \leq \omega \leq 0.2\pi$

   $|H(\omega)| \leq 0.2 \quad 0.32\pi \leq \omega \leq \pi$

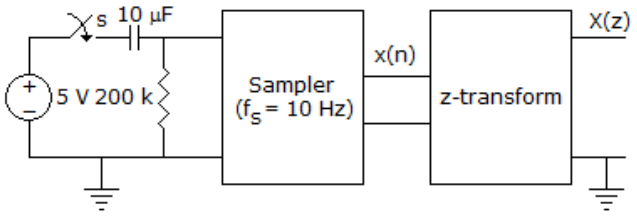
   Inspect the Butterworth IIR digital filter using Impulse invariant transformation technique and Bilinear Transformation technique
3. Compare the frequency response of Linear phase FIR filter

   Case (1) impulse response $h_{(n)}$ is symmetrical N is odd

   Case (2) impulse response $h_{(n)}$ is anti symmetrical N is even

   Case (3) impulse response $h_{(n)}$ is symmetrical N is even

   Case (4) impulse response $h_{(n)}$ is anti-symmetrical N is odd
4. In the following network, the switch is closed at t=0 − and the sampling starts from t=0. The sampling frequency is 10Hz.



Examine the region of convergence of Z-Transform of sampled signal.

23EE009 Machine Modelling and Steady State Analysis

3 0 2 4

Course Outcomes

1. Outline the basic principles of Electrical machines
2. Examine the working of a DC machine under static and dynamic conditions
3. Summarize the reference frame theory
4. Analyze the performance of synchronous machines under steady state and dynamic conditions
5. Analyze the performance of Induction machines under steady state and dynamic conditions
6. Demonstrate the working of an electrical machine under various dynamic conditions

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2		2				3	3	3
CO2	3	3	3	3	3	3		2				3	3	3
CO3	3	3	3	3	3	3		2				3	3	3
CO4	3	3	3	3	3	3		2				3	3	3
CO5	3	3	3	3	3	3		2				3	3	3
CO6	3	3	3	3	3	3		2				3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-I

Basic Principles for Electric Machines

Magnetically coupled circuits, Nonlinear magnetic system, Electro-mechanically energy conversion, Energy in coupling fields, steady state and dynamic performance of an electromechanical system, machine windings and air gap mmf, winding inductances and voltage equations.

Inductance machine mmf

Practical Component

1. Simulation of magnetic coupled circuit
2. Simulation of dynamic performance of an electromechanical system

12+8 Hours

Unit-II

Analysis of DC-machine

Elementary DC machine, voltage and torque equations, dynamic characteristics of DC motors, Dynamic performance during starting and load change conditions, state equations.

Reference frame theory: Equations of transformation, conversion of stationary variables to arbitrary reference frame, Transformation between reference frames

Commonly used reference frames

Practical Component

1. Simulation of the dynamic behavior of permanent DC motor
2. Simulation of the dynamic behavior of shunt DC motor
3. Simulation of transformation of variables between reference frames

12+8 Hours

Unit-III

Analysis of Synchronous machine

Voltage equations in machine variables, Torque equation, Stator voltage equations in arbitrary reference-frame variables, Voltage equations in rotor reference-frame variables, rotor angle and angle between rotors, Analysis of steady state operation, Dynamic operation during sudden change in torque

Practical Component

1. Simulation of hydro turbine generator under dynamic conditions
2. Simulation of dynamic behavior of steam turbine generator during a step increase of input torque
3. Simulation of dynamic performance of hydro turbine generator during three phase fault

Approximate Transient Torque versus Rotor Angle Characteristics

12+8 Hours

Unit-IV

Analysis of Induction machine

Voltage equations in machine variables, Torque equation, equations of transformation for rotor circuits, voltage equations in arbitrary reference-frame variables, Analysis of steady state operation, Dynamic operation during sudden change in torque.

Per unit system.

Practical Component

1. Simulation of Torque–speed characteristics during free acceleration
2. Simulation of free acceleration characteristics of a 10-hp induction motor in a reference frame fixed in rotor
3. Simulation of free acceleration characteristics of a 10-hp induction motor in the synchronously rotating reference frame

12+8 Hours

Total: 48+32=80 Hours

Text Book(s)

1. Krause, Paul C., Oleg Wasynczuk, Scott D. Sudhoff, and Steven Pekarek. "*Analysis of electric machinery and drive systems*," Vol. 3. New York: IEEE press, 2013.
2. Krishnan, Ramu. "*Electric motor drives: modeling, analysis, and control*," Pearson, 2001.

Reference Book(s)

1. Chee, Mun Ong. "*Dynamic Simulations of Electric Machinery: Using MATLAB/SIMULINK*." (1997).

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Laboratory Test (%)
Remember	20	20	---
Understand	50	30	---
Apply	---	---	---
Analyze	30	50	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Understand

1. Derive torque equation of induction machine in terms of machine variables.
2. Obtain the transfer function of a separately excited DC motor by considering armature inductance, L_a and load torque, T_L in terms of undamped natural angular frequency and damping factor.
3. Obtain the mathematical model of DC series motor in state variable form.

Apply

1. A two-winding, iron-core transformer is shown in Figure 1P-1. N1=50 turns, N2=100 turns, and μR=4000. Calculate Lm1 and Lm2.
2. A three-phase, 64-pole, hydro turbine generator is rated at 325 MVA, with 20 kV line-to-line voltage and a power factor of 0.85 lagging. The machine parameters in ohms at 60 Hz are: r_s= 0.00234, X_q= 0.5911, and X d= 1.0467. For balanced, steady-state rated conditions, calculate T_e.
3. Show that for a two-phase set $f_{as}^2 + f_{bs}^2 = f_{qs}^2 + f_{ds}^2$

Analyze

1. Analyze the performance of synchronous machines under steady state and dynamic conditions
2. Analyze the performance of induction machine under steady state and dynamic conditions
3. Analyze the performance of a DC shunt motor with sudden change in load torque

4. The precise motor positioning of a salient-pole synchronous generator which has large number of poles is difficult to attain because the mechanical angle between adjacent d- and q-axes is very small. Even with the 1.4 MVA hydro generator with 10 poles, the rotor positioning proved to be very difficult. More attention should be paid to the rotor positioning of a salient-pole synchronous machine. The estimated d-axis operational inductance at zero frequency Ld(0) of the hydro-generator showed a large difference from the value obtained from the conventional test whereas the estimated q-axis Lq(0) is within 15 % of the design value. Why inaccurate motor positioning has more effect on the d-axis? **(For Open Book Examination and not for semester end examination)**

5. The d-axis operational impedance shows a phase decreased in the high frequency range, while this is not so prominent for q-axis tests. What can be the reason for this? What is the possibility of eddy current loss on the operational inductance values? **(For Open Book Examination and not for semester end examination)**

23EE606 Power Systems lab

0 0 3 1.5

Course Outcomes

1. Interpret various characteristics of over current and voltage relays
2. Interpret various characteristics of distance relays
3. Inspect the breakdown strength of the oil
4. Assess the characteristics of a fuse
5. Evaluate the performance of long transmission lines
6. Summarize compensation techniques

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				2	3	3	2		2			3	2	
CO2				2	3	3	2		2			3	2	
CO3				3	3	2	2		2			2	1	
CO4				3	3	2	2		2			2	2	
CO5				3	3	3	2		2			3	3	
CO6				3	3	3	2		2			3	3	

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

List of Experiments

Perform any 10 experiments from the given list

1) Simulation of performance characteristics of medium transmission lines
2) To study the characteristics of under voltage induction relay
3) To study the characteristics of attraction type relay
4) To study the characteristics of over current induction relay
5) To study the characteristics of directional over current relay
6) To study time vs. differential current characteristics of percentage biased differential relay
7) To study time vs. current characteristics of digital distance relay
8) To determination of breakdown strength of oil by variable distance Electrodes
9) To find the time vs. current characteristics of fuse
10) To study the characteristics of earth fault relay
11) To find the A, B, C, D parameters of the long transmission line
12) To find voltage regulation of the long transmission line under no-load and loaded condition
13) Application of compensation techniques to improve the performance of long transmission line

List of Augmented Experiments[1]

1. Development of over voltage protection
2. Development of under voltage protection
3. Development of over current relay
4. Development of a transmission line model

Text Books:

1. Ned Mohan *"Electric Power System"* John Wiley & Sons Inc, 2012
2. Badari Ram and D.N Vishwakarma, *"Power System Protection and Switchgear",* TMH Publications, 2nd Edition, 2011
3. I. J. Nagaraj and D. P. Kothari, *"Modern Power System Analysis"* Tata McGraw Hill, 3rd Edition, 2007
4. Sunil S Rao *"Switchgear and Protection"*, Khanna Publishers, 13th edition, 2017

[1]Students shall opt any one of the Augmented Experiments in addition to the regular experiments

23MPX01 Mini Project

0 0 3 1.5

Course Outcomes

1. Identify a contemporary engineering application to serve the society at large
2. Use engineering concepts and computational tools to get the desired solution
3. Justify the assembled/fabricated/developed products intended
4. Organize documents and present the project report articulating the applications of the concepts and ideas coherently
5. Demonstrate ethical and professional attributes during the project implementation
6. Execute the project in a collaborative environment

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	3	2	2	2	2	2	3	3	3
CO2	3	3	3	2	3	3	3	3	2	3	2	3	3	3
CO3	2	3	3	3	3	3	3	2	2	2	2	3	3	3
CO4	2	2	3	3	3	3	3	3	3	3	2	3	3	3
CO5	3	3	2	2	3	3	3	3	3	2	3	3	3	3
CO6	3	3	2	2	3	3	3	3	3	3	2	3	3	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

23ESX02 Employability Skills II **0 0 2 2**

Course Outcomes

1. Demonstrate oral communication and writing skills as an individual to present ideas coherently
2. Develop life skills with behavioral etiquettes and personal grooming
3. Assess analytical and aptitude skills
4. Develop algorithms for engineering applications
5. Solve engineering problems using software
6. Utilize simulation tools for testing

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1	1	1	1			2	3		3	1	
CO2	1		1	1	1	1			2	3		3	1	
CO3	1		1	1	1	1			2	2		3	1	
CO4	2		2	2	2	2			3	1		3	1	
CO5	3		2	2	2	2			3	1		3	2	
CO6	2		2	2	3	3			3	1		3	3	

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

PART-A

Soft Skills

Resume (Recap): Resume? Templates? Mistakes to be avoided in a Resume and Steps to be followed in preparing it.

Group Discussions (Recap) & Practice: GD? Stages of a GD, Skills assessed in a GD, Blunders to be avoided, How to excel in a GD? Practice sessions and sharing Feedback. (Screening sample Videos)

Interview Skills: Interview? Types of Interview, Dos & Don'ts, Skills assessed in an Interview, Mistakes to be avoided, How to equip oneself to excel? How to handle the Typical Interview Questions? (with Examples)

Mock Interviews: Practice sessions with Feedback.

Exercises related to Communication: Email Writing, Voice Versant., etc.

7 Hours

PART-B

Aptitude Skills

Time and Distance, Time and Distance, Problems on Trains, Problems on Trains, Blood relations, Ratio and Proportions, Calendars and Clocks

8 Hours

PART-C

Domain Specific Knowledge

Programmable logic controllers -4

i. Implementation of up-down counter
ii. DC motor direction control
iii. Implementation of PID controller
iv. Implementation of half wave rectifier using PLC
v. PLC implementation for an automation industry

15 Hours

Total: 30 Hours

Text Book (s)

1. Frederick D. Hackworth and John R. Hackworth, *Programmable Logic Controllers: Programming Methods and Applications*, Pearson India; 1st edition, 2003.
2. Frank Petruzella, *Programmable Logic Controllers*, Tata McGrawhill, 3rd Edition, 2011.

Reference (s)

1. Gary Dunning, Thomson Delmar, "*Programmable Logic Controller*", Cengage Learning, 3rd Edition, 2005.
2. W. Bolton, "*Programmable Logic Controllers*", Newnes – Elsevier, 2015.

Audit Course

0 0 0 0

Course Outcomes

1. Interpret the meaning of values and select their goals by self- Investigation based on personal values
2. Interpret the major events and issues related to a period in Indian history
3. Assess the benefits and limitations of science and its application in technological developments towards human welfare
4. Check the awareness regarding basic human rights and to uphold the dignity of every individual
5. Assess the individual and group behaviour, and understand the implications of organizational behaviour on the process of management
6. Determine the appropriateness of various leadership styles and conflict management strategies used in organizations

COs – POs Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2	3	1	2		2		
CO2						3	2	1	1	1		1		
CO3						2	3	1	1	1		2		
CO4						3	2	3	1	2		2		
CO5						2	2	1	3	2		1		
O1						2	2	3	1	2		2		

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

23EEC13 Battery Management Systems

3 0 0 3

Course Outcomes

1. Outline the battery management system in detail.
2. Summarize the requirements of battery management system.
3. Outline the State of Charge model in detail.
4. Illustrate Cell Balancing model in detail.
5. Demonstrate the battery charging algorithms.
6. Summarize Battery charging standards and safety Issues.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1		2	1			1	1					2	3	2
CO2		2	1			2	2					2	3	2
CO3		2	1			1	1					2	3	2
CO4		2	3			2	2					2	3	2
CO5		2	3			2	2					2	3	3
CO6		2	3			3	3					2	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Battery Management System

Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

Analysis of different battery technologies

12 Hours

Unit II

Battery Management System Requirement

Battery-pack topology, BMS design requirements, Battery-pack sensing: Voltage, Temperature, Current; State of charge estimation, Energy estimation, and Power estimation.

Importance of battery management

12 Hours

Unit III

Battery-State and Health Estimation

Battery State of Charge (SOC) estimation, some approaches to estimate SOC. Need for health estimates, Negative-electrode aging, Positive-electrode aging, Cell Balancing: Causes of imbalance, Not causes of imbalance, Balancer design choices, Circuits for balancing.

State of health analysis of different batteries

12 Hours

Unit IV

Battery charging standards and safety Issues

Battery charging standards and algorithms, Power limits, Cold temperature performance, Lithium-Ion battery safety issues, Battery aging, Energy balancing with multi-battery system.

Energy balancing with different battery technologies

12 Hours

Total: 48 Hours

Textbook (s)

1. Plett, Gregory L. *Battery management systems, Volume I: Battery modelling*. Artech House, 2015.
2. Plett, Gregory L. *Battery management systems, Volume II: Equivalent-circuit methods*. Artech House, 2020.

Reference (s)

1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "*Battery Management Systems -Design by Modelling*" Philips Research Book Series 2002.
2. Davide Andrea," *Battery Management Systems for Large Lithium-ion Battery Packs*" Artech House, 2010.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Examination (%)
Remember	25	30	--
Understand	70	70	--
Apply	--	--	100
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define Battery Management System
2. Recall the concept Battery pack technologies
3. List any twoBattery Management System design requirements
4. List any two battery charging standards
5. List any two Safety issues related to battery charging technologies

Understand

1. Explain the State of charge estimation.
2. Explain Cell balancing model in detail.
3. Outline the battery charging algorithms in detail.
4. Explain positive and negative electron gain.
5. Explain the Energy balancing mechanism with multi-battery system.

Apply:

1. Compare the batteries performance when the cells are connected n series and parallel.
2. Compare the energy and power estimation concepts.
3. Mr. Ram a businessman needs to travel daily on an average covering 100km which consists of 70 km highway drive and 30 km city drive. He is currently using a diesel vehicle and wants to shift to non-polluting/less polluting vehicle. Help him identify which vehicle he can opt with a suitable battery technology, so that it would cater to his needs as well as reduce his vehicle carbon footprint. Justify your selection make use of EV/HEV specifications available in the market.**(For Open Book Examination and not for semester end examination)**
4. An electric vehicle is designed using the hybrid model, and it is tested on a flat track in a high-speed manner to ensure the vehicle's performance. Select the appropriate battery technologies to match the characteristics of a high-powered electric vehicle, as well as the time of operation required to charge the chosen battery technologies, also recommend a suitable location for the charging station by selecting a suitable technology to charge the selected battery. **(For Open Book Examination and not for semester end examination)**
5. Mention the performance of the battery by operating the vehicle in different possible modes. **(For Open Book Examination and not for semester end examination)**

23EEC23 Hybrid Renewable Energy Systems Design

3 0 0 3

Course outcomes

1. Outline hybrid energy system
2. Identify the various converter topologies for hybrid energy systems.
3. Identify the various control strategies in the hybrid system
4. Outline the planning and modeling of solar and wind energy systems
5. Summarize the storage and control system for hybrid renewable energy systems
6. Examine the application of storage and control system for hybrid model

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1		2	2			1	3					3	2	2
CO2		3	3			1	2					3	2	2
CO3		3	3			1	2					3	2	2
CO4		3	3			2	3					3	2	2
CO5		3	3			2	3					3	2	2
CO6		3	3			2	3					3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit:I

Fundamentals of Hybrid Energy Systems

Design and planning of hybrid system, Different Combinations of Hybrid Systems- PV System with Battery Storage, Hybrid Wind/Photovoltaic System, PV-diesel-battery system, Holistic planning approach.

Present Indian energy scenario of conventional and RE sources

12 Hours

Unit:II

Power Electronics Applications in Hybrid Energy Systems

AC and DC bus connected HES, DC-side integration of HES- Cascaded DC-connection, Series DC connection, Parallel DC connection, DC-side integrated hybrid energy storage systems, Three-port converters. AC side integration of HES.

Multi-level converter for hybrid energy systems.

12 Hours

Unit:III

Design of Hybrid Renewable Energy Systems

Photovoltaic plant planning for hybrid micro grids, Technical considerations for hybrid micro grids, Photovoltaic system design, Wind power plant planning and modeling, Design of wind System- Wind energy production estimate, Design of Hybrid Photovoltaic/Wind System/Fuel Cells (ADD SOME SUB TOPICS)

Environmental impacts of solar and wind energy system.

12 Hours

Unit:IV

Energy Storage System and Control

Need for ESS, Types of ESS configuration: passive configuration, semi active configuration, series active configuration, parallel active configuration, Control Strategies for hybrid energy storage system configurations, Control of microgrid configuration based on solar-photo voltaic-wind turbine and hybrid energy storage system.

Case studies of Wind-PV Maximum Power Point Tracking (MPPT)

12 Hours

Total: 48 Hours

Textbook (s)

1. Kabalci, Ersan, Ed. "*Hybrid renewable energy systems and micro-grids*", Academic Press, 2020.
2. Djamila Rekioua, "*Hybrid Renewable Energy Systems-Optimization and Power Management Control*", Springer 2020
3. Umakanta Sahoo, "*Hybrid Renewable Energy Systems*", Scrivener Publishing LLC, 2021.

Reference (s)

1. Fu Y., Yang J. and Zuo T. (2011); *Optimal sizing design for hybrid renewable energy systems in Rural Areas*, Springer.
2. Tester J. W. (et al.) (2012); *Sustainable Energy: Choosing among Options*, Second Edition, MIT Press.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Examination (%)
Remember	30	10	---
Understand	30	40	---
Apply	30	30	60
Analyze	10	20	40
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define photovoltaic
2. List any two power electronic converters used in DC microgrid.
3. Select a suitable DC-DC converter for a solar PV system.
4. Draw the equivalent circuit of PV cell.
5. Classify different energy storage systems.

Understand

1. Derive the expression of fundamental relationship for the power delivered by the rotor and obtain Betz efficiency.
2. Illustrate series and parallel active configuration of energy storage system.
3. Illustrate different indexes used in hybrid photo voltaic system.
4. Illustrate Betz criteria in detail.

Apply

1. Build a suitable control strategy for hybrid solar PV system and wind turbine system.
2. Model a suitable DC-DC converter for the following data. Input Voltage 12 V, Output Voltage 48 V, Duty Cycle 75% , Switching frequency 50 KHz.
3. Identify different converters required for hybrid wind-PV system and discuss their significance.
4. Identify different parameters need to be considered in design of hybrid wind and solar system.

Analyze

1. Classify different energy storage systems and analyze their performance under static and dynamic working conditions.
2. Inspect the different challenges in wind energy system in hybridization of wind- solar system.
3. A certain water heater is when operated from 230 V a.c will deliver a power of 2.88 kW. Now this heater (electrical resistance heating element) is directly connected to the PV system. Assume that you have 4 identical PV modules. Make necessary assumptions and Plot the I-V curves of different combinations of PV modules and decide which combination will give the most energy in a day time. Justify. (**For Open Book Examination and not for semester end examination**).

23EEC33 Communication and Security in Smart Grid

3 0 0 3

Course Outcomes

1. Summarize wireless, wire line, and optical communication solutions to smart grid
2. Exemplify the different kind of networks of Wireless Communications in Smart Grids
3. Identify the various technologies of wire line communications in smart grids
4. Summarize the security models for SCADA, ICS, and Smart Grid
5. Identify the various security threats and standardization,
6. Outline the authentication and encryption key management in smart grid

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	2	2			1	3	2				2	3	3
CO2	3	3	3			1	2	2				2	3	3
CO3	3	3	3			1	2	2				2	3	3
CO4	3	3	3			2	3	2				2	3	3
CO5	3	3	3			2	3	2				2	3	3
CO6	3	3	3			2	3	2				2	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Wireless Communications in Smart Grids

Introduction, Overview of Data link Control and Media access control, wireless personal area networks, wireless local area networks, wireless metropolitan area networks, cellular networks, satellite communications - frequency bands and propagation effects

Fixed Satellite Systems

12 Hours

Unit II

Wire line Communications in Smart Grids

Introduction - phone line technology, coaxial cable technologies, power line technology - plc scenarios, channel, and noise aspects, power line communication (PLC) electromagnetic compatibility regulations, narrowband PLC and broadband PLC.

Optical Communications in Smart Grids

12 Hours

Unit III

Security Models for supervisory control and data acquisition (SCADA) and Smart Grid

National Institute of Standards and Technology Framework - NISTIR 7628 Smart grid cyber security architecture, European Union Mandate - EU M/490 and the Smart Grid Coordination Group (SGCG) reference architecture for the smart grid, mapping security requirements to smart grid environments, applying the "3×3" cyber security model to smart grids.

Zone separation in a Smart Grid

12 Hours

Unit IV

Smart Grid Security Standardization

Smart Grid Security Requirements. Security Relevant Regulation and Standardization Activities - ISO/IEC, IEEE and CIGRE, Trends in Energy Automation Security. Smart Grid Authentication and Key Management - Authentication and Authorization Issues in the Smart Grid

Malware Protection

12 Hours

Total: 48 Hours

Textbook (s)

1. Lars T. Berger, Krzysztof Iniewski, "*Smart Grid Applications, Communications, and Security*", Wiley, April 2012
2. Eric D. Knapp and Raj Samani, "*Applied Cyber Security and the Smart Grid: Implementing Security Controls into the Modern Power Infrastructure*", Syngress (Elsevier), 2013.

3. Florian Skopik, Paul Smith, "*Smart Grid Security Innovative Solutions for a Modernized Grid*", Syngress (Elsevier), 2015.

Reference (s)

1. Anuradha Tomar and Ritu Kandari, "*Advances in Smart Grid Power System Network, Control and Security* ", Academic Press, 2021.
2. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, "*Smart Grid: Technology and Applications*," John Wiley & Sons, 1st Edition, 2015.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Examination (%)
Remember	25	25	---
Understand	35	35	---
Apply	40	40	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. What is wireless personal area network?
2. What is power line technology?
3. What are mapping security requirements to smart grid environments?
4. What are Smart Grid Security Requirements?

Understand

1. Explain the metropolitan area networks & cellular networks.
2. Explain NISTIR 7628 Smart grid cyber security architecture.
3. Explain Authorization Issues in the Smart Grid.

Apply

4. Identify which one is having more merits in narrowband plc and broadband PLC.
5. Utilize the Security Relevant Regulation and Standardization Activities - ISO/IEC, IEEE and CIGRE.
6. Identify the best architecture for the smart grid and explain it.
7. A smart grid's Supervisory Control and Data Acquisition (SCADA) system is a critical component. SCADA devices exchange data using a variety of different communication protocols, physical media, and security properties. Failures or attacks on such networks have the potential to result in data loss and false data injection, resulting in incorrect system estimations and control decisions, resulting in severe consequences such as power outages and equipment destruction. Develop an automated framework for SCADA security and resiliency analysis in smart grids. This framework should take smart grid configurations and organizational security and resiliency requirements as inputs, formalize configurations and various security constraints. (**For Open Book Examination and not for semester end examination**).
8. Smart Grids use both one-way and two-way communication to work, whereas traditional power grids mostly use one-way communication to work. The communication needs and best methods change depending on the environment and the situation. Survey all of the communication technologies used in the SG, including the communication requirements, physical layer technologies and network architectures. This should be a complete and up-to-date survey. (**For Open Book Examination and not for semester end examination**).

23EE010 Electrical Distribution Systems

3 0 0 3

Course Outcomes

1. Interpret the concept of load modeling, characteristics and feeders
2. Outline the design of substations
3. Analyze voltage drop and line loss issues
4. Analyze the Coordination of Protective Devices.
5. Illustrate compensation methods for voltage control
6. Summarize the different pf improvement methods

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	2	2			3	3	2				2	3	3
CO2	3	3	3			2	3	2				2	3	3
CO3	3	2	3			3	3	2				2	3	2
CO4	3	2	3			3	3	2				2	3	2
CO5	3	2	3			2	3	2				2	3	2
CO6	3	2	3			2	3	2				2	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit – I

General Concepts & Distribution feeders

Introduction to distribution systems, Load modeling and characteristics. Coincidence factor, contribution factor, loss factor - Relationship between the load factor and loss factor. Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics. Design Considerations of Distribution Feeders: Radial and loop types of primary feeders, voltage levels, Feeder loading; basic design practice of the secondary distribution system.

Load Forecasting

12 Hours

Unit – II

Substations & System Analysis

Location of Substations: Rating of distribution substation, service area with n primary feeders. Benefits Derived through optimal location of substations. Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks.

Three phase balanced primary lines.

12 Hours

Unit – III

Protection & Coordination

Objectives of distribution system protection, types of common faults and procedure for fault calculations. Protective Devices: Principle of operation of Fuses, Circuit Reclosures, line sectionalizes, and circuit Breakers. General coordination procedure, Coordination of Protective Devices.

Location of Sectionalizer

12 Hours

Unit – IV

Compensation for power factor Improvement & Voltage control

Shunt and series capacitors, effect of shunt capacitors (Fixed and switched), Power factor correction, capacitor allocation - Economic justification - Procedure to determine the best capacitor location. Voltage Control: Static Var compensator, Static Synchronous Compensator, Thyristor Controlled Series Compensator, Thyristor Controlled Reactor.

Effect of AVB/AVR, line drop compensation.

12 Hours

Total: 48 Hours

Textbook (s)

1. Turan Gonen, "*Electric Power Distribution system, Engineering*", Mc Graw-hill Book, 3rd edition,2014

2. A.S. Pabla, "*Electric Power Distribution*", Tata Mc Graw-hill Publishing Company, 7th edition,2019

Reference (s)

1. S.Sivanagaraju, V.Sankar, "*Electrical Power Distribution and Automation*", Dhanpat Rai & Co, 2015
2. V.Kamaraju, "*Electrical Power Distribution Systems*", Mc Graw-hill Publishing Company,2017

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book/Assignment Test (%)
Remember	40	20	---
Understand	40	40	---
Apply	20	40	70
Analyze	---	---	30
Evaluate	---	---	
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define the term Load Diversity
2. Define Contribution factor
3. Define the Nominal voltage
4. Define Rated voltage

Understand

1. Explain different types of electric supply systems.
2. Explain the characteristics of residential, industrial and commercial loads
3. Explain the different factors to be considered to decide the ideal location for a substation.
4. Explain the practical procedure to determine the best capacitor location.

Apply

1. Derive the expression for voltage drop for non-three phase system
2. A synchronous motor having a power consumption of 40 KW is connected with a load of 150KW, a lagging p.f of 0.8. If the combined load has a power factor of 0.9, Determine the leading reactive KVA supplied by the motor and at what p.f is it working.
3. In a radial feeder the load is connected at the receiving end. The impedance of the feeder is (0.11+j0.1) p.u, the sending end voltage is 1.0p.u, the real load and power factor at the receiving end are 1.0p.u and 0.8 lagging. Determine the receiving end voltage, load angle and find the corresponding values of the receiving end and sending end currents.
4. Develop the Fuse-circuit breaker coordination procedure.

Analyze

1. Compare the % voltage drop of the feeders with square type service area and hexagonal type service area
2. Classify different types of primary feeders and give their merits and demerits
3. A three radial feeder has a voltage of 10.5 kV at the receiving end, a total impedance of 5.25+j10.91 ohm/ph and the load of 5MW with a lagging power factor of 0.9. Then determine the three phase line and phase voltage at the sending end, load angle and the percentage voltage regulation.
4. Analyze the GMR Solar Power plant is Connected to grid with a primary distribution having 1MW generation in campus to meet the load demand. In the view of the substation associated to this power plant, justify your answers with suitable combinations.
   i.Analyze the protective relay, which we can use in the system for protection of line to ground fault ii. Compare over SF6 and airblast Circuit breaker which is more beneficial for this grid with normal operating conditions. iii. Build appropriate coordination between different protection schemes (**For Open Book Examination and not for semester end examination**).
5. Analyze the coordination among the Protective devices used in Distribution system. **(For Open Book Examination and not for semester end examination).**

23EC401 Analog and Digital Communications

3 0 0 3

Course Outcomes

1. Explain Analog Modulation & Demodulation techniques
2. Summarise the noise level in Analog communication systems
3. Demonstrate the operations of Transmitters and Receivers
4. Explain different pulse modulation techniques
5. Illustrate different digital modulation and demodulation techniques
6. Outline the operations of digital communication receivers

COs-POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	2	2			1						2	2	2
CO2	3	3	2			1						2	2	2
CO3	3	3	3			1						2	2	2
CO4	3	3	3			2						2	2	2
CO5	3	3	3			2						2	2	2
CO6	3	3	3			2						2	2	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Amplitude Modulation and Frequency Modulation

Introduction to communication system, Need for modulation, Frequency Division Multiplexing, Amplitude Modulation, power relations in AM waves, Generation of AM waves: square law Modulator, Principle of Detection of AM Wave: Envelope detector. DSB Modulation: Double side band suppressed carrier modulators, Generation of DSBSC Waves, Coherent detection of DSB-SC Modulated waves.
SSB Modulated Wave, Vestigial side band modulation: Generation of VSB Modulated wave.
Frequency Modulation: FM Wave, Narrow band FM, Wide band FM, Generation of FM Waves, Direct FM, Detection of FM Waves: Balanced Frequency discriminator.
Switching modulator, COSTAS loop

12 hours

Unit II

Noise, Analog Transmitters and Receivers

Noise in DSB & SSB System Noise in AM System, Noise in Angle Modulation System, Threshold effect in Angle Modulation System, Pre-emphasis & de-emphasis AM Transmitter, FM Transmitter - Variable reactance FM Transmitter, Super heterodyne receiver, Comparison of FM and AM Receiver.
Phase modulated FM transmitter, Phase locked loop

12 hours

Unit III

Pulse modulation

PAM, PWM, PPM, Model of Digital Communication Systems, Digital Representation of Analog Signal, Certain issues in Digital Transmission, Advantages of Digital Communication Systems , Pulse Code Modulation: PCM Generation and Reconstruction, Quantization noise, Non uniform Quantization and Companding, Time Division Multiplexing, DPCM, DM and Adaptive DM.
Classification of line encoding techniques, TDM Frame Structures

12 hours

Unit IV

Digital Modulations

Introduction, ASK, FSK Modulator, Coherent ASK Detector, Non-Coherent ASK Detector, FSK, Bandwidth and Frequency Spectrum of FSK, Non coherent FSK Detector, Coherent FSK Detector, BPSK, Differential PSK DEPSK, QPSK, MPSK, MSK, Probability of Error, Correlation Receiver, Matched filter Receiver.
Telemetry, OQPSK

12 hours
Total: 48 hours

Textbook (s)

1. H.Taub and D. Schilling, *Principles of Communication Systems*, TMH,4th Edition, 2017
2. Simon Haykin , *Digital communications*, John Wiley, 4th Edition,2013
3. Simon Haykin , *An Introduction to Analog& Digital Communications*, John Wiley, 2nd Edition, 2012
4. George Kennedy and Bernard Davis , *Electronic Communication Systems*, TMH, 4th Edition, 2004

Reference (s)

1. R.P. Singh, SP Sapre, *Communication Systems* TMH, 3rd Edition, 2017
2. B.P.Lathi, Zhi Ding, *Modern Digital and Analog Communication Systems*, Oxford, 4th Edition, 2011
3. John G. Proakis, Masond, Salehi, *Fundamentals of Communication Systems*, Pearson Education, 3rd Edition, 2008
4. H Taub & D. Schilling, Gautam Sahe, *Principles of Communication Systems* , TMH, 3rd Edition. 2007
5. Sam Shanmugam, *Digital and Analog Communication Systems*, John Wiley, 2005
6. Bernard Sklar, *Digital communications Fundamentals and applications*, 2nd Edition, PHI, 2001

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Exam (%)
Remember	25	25	--
Understand	50	50	--
Apply	25	25	80
Analyse	--	--	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. Define angle modulation.
2. Define modulation index.
3. List any two advantages of DSBSC.
4. List any two advantages of VSB.
5. Define quantization noise power.
6. Define QAM, and draw its constellation diagram.

Understand

1. Explain the need for modulation.
2. Illustrate the operation of square law modulator.
3. Compare SSB modulation with DSB-SC modulation.
4. Illustrate the operation of Frequency modulation.
5. Represent a neat block diagram of a typical digital communication system and explain the function of the key signal processing blocks.
6. Explain Binary PSK and QPSK with corresponding equations and constellation diagrams.

Apply

1. The antenna current of an AM transmitter is 8A when only the carrier is sent, but it increases to 8.93A when the carrier is modulated by a single sine wave. Calculate the percentage modulation. Find the antenna current when the percentage of modulation changes to 0.8.
2. An FM signal with single tone modulation has a frequency deviation of 15KHz and a bandwidth of 50KHz. Find the frequency of the modulating signal.
3. Execute the channel synchronization method in PCM systems.
4. A standard AM broad cast station is allowed to transmit 12 signals ,each band limited to 5KHz and are to be transmitted over a single channel by FDM. If AM –SSB modulation with guard band of minimum value is used, Find the band width of the multiplexed signal. Predict the number of signals can be used if AM-DSBSC is used by the broad cast station instead of AM-SSB for the same bandwidth. **(For Open Book Examination and not for semester end examination).**
5. a) A QPSK signal is used to send data over a satellite transponder. The transponder has a bandwidth of 12MHz.A TV channel is planned to use two data rates of 18MHz and 28MHz.Find which data rate can be supported by the transponder and Justify the reason.

b) For the same transponder, Find whether the TV channel can use the data rates of 15MHz and 30 MHz or not. **(For Open Book Examination and not for semester end examination).**

Analyse

1. Certain transmitter is radiating 132KW when a certain audio sinewave is modulating it to a depth of 80% and 150KW when a second sinusoidal audio wave also modulates it simultaneously. What is the depth of modulation for the second audio wave?
2. When the modulating frequencies in an FM system is 400Hz and the modulating voltage is 2.4v the modulation index is 60. What is the modulation index when the modulating frequency is reduced to 250 Hz and the modulating voltage is simultaneously raised to 3.2V Calculate the maximum deviation.
3. Outline the signal space diagram of quadrature amplitude modulation and its differences with respect to QPSK. Analyze different ways of increasing the efficiency of steam power plant by giving appropriate justification.
4. a) An All India radio station uses a carrier wave of 1MHz and whose amplitude is 3V is frequency modulated by a sinusoidal modulating signal frequency of 500Hz and of peak amplitude 1V.The peak deviation of the modulating wave form is 1KHz.The peak level of the modulating waveform is changed to 5V and the modulating frequency changed to 2KHz.Then find the expression for the new modulated wave and compare the parameters such as deviation ratio, Bandwidth and the number of side bands of FM waves.

   b) In the radio station if the carrier wave is changed to a square wave for the same specifications find the expression of the modulated wave and compare the parameters of the FM waves with sine and square modulating signals.**(For Open Book Examination and not for semester end examination).**
5. a) In a music competition, recording is done by sampling and storing the sample values .If the highest frequency tone to be recorded is 15800Hz, Examine the number of sample would be required to store three minutes performance. Conclude the number of binary digits would be required to store the three minutes performance if each sample is quantized in to 128 levels.

   b) Find the number of binary digits required to store 5 minutes performance if each sample is quantized in to 64 levels.**(For Open Book Examination and not for semester end examination).**

23IT304 Database Management Systems

3 0 0 3

Course Outcomes

1. Understand the fundamental concepts of data base and data models
2. Explain the use of Relational Algebra and integrity constraints in databases
3. Use SQL's Commands to handle the Database
4. Apply Normalization for schema refinement
5. Make use of the concept of transaction management and recovery system in databases
6. Outline Indexing concepts, different types of data

CO–PO Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	3	3			3		2				2		
CO2	3	3	3			3		2				2		
CO3	3	3	3			3		2				2		
CO4	3	3	3			3		2				2		
CO5	3	3	3			3		2				2		
CO6	3	3	3			3		3				3		

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to DBMS and ER Model

DBMS Vs. File System, instance and schema, Data abstraction, Data independence, database users and database administrator, Database system structure, Introduction to Data Models (E-R Model, Relational Model, Hierarchical Model, Network Model, Object Oriented Data Model), Database Design Process, Entities, Attributes, Entity Sets, Relationships, Relationship Sets, Additional features of ER Model.

Applications of DBMS, Object Relational Data Model

12 Hours

Unit II

Introduction to Relational Model and Basic SQL Queries

Relational Algebra Operations: Selection, Projection, Rename, Set Operators, Joins, Division, Examples of Relational Algebra Queries, Relational Calculus: Tuple Relational Calculus.

Integrity Constraints over Relations, Introduction to Views.

SQL Queries: Basic Structure, Set Operations, Aggregate Functions, Null values, Sub Queries, Group By And Having Clauses, Outer Joins.

Domain Relational Calculus, Query Optimization

12 Hours

Unit III

Normalization and Transaction Management

Introduction To Schema Refinement - Problems Caused By Redundancy - Decomposition - Problems Related To Decomposition - Functional Dependency - Closure of a Set of Fds - Attribute Closure - First - Second - Third Normal Forms – BCNF - Multi Valued Dependencies – Fourth Normal Form, Join Dependency, Fifth Normal Form

Transactions: Acid Properties of Transaction - Transaction States - Schedule: Serial Schedule - Concurrent Schedules - Anomalies Associated with Concurrent Schedules (RW - WR - and WW Conflicts) -Serializability - Conflict Serializability - and View Serializability.

EF Codd Rules, Domain Dependency

12 Hours

Unit IV

Locking, Recovery Systems, Indexing, Different Types of Data

Introduction to Lock Management-Lock Based Concurrency Control: 2pl-Strict 2pl-Concurrency without Locking: Timestamp–Based Concurrency Control, Optimistic Concurrency Control.

Introduction to Aries - the Log - the Write-Ahead Log Protocol-Check Pointing Indexing: Types of Single-Level Ordered Indexes, Multilevel Indexes Different Types of Data: Structured, Semi-Structured and Unstructured Data

Heap File, Hash File Organizations

12 Hours
Total: 48 Hours

Textbook (s)

1. Elmasri & Navatha, *Fundamentals of Database Systems*, Pearson Education, 7th Edition, 2016
2. Silberschatz Korth, *Database System Concepts*, McGraw hill, 7th Edition, 2019

Reference (s)

1. Soraya Sedkaoui, *Data Analytics and Big Data*, Wiley, 1st Edition, 2018.
2. Peter Rob & Carlos Coronel, *Database Systems design, Implementation and Management*, 9th Edition, 2010.
3. Raghurama Krishnan & Johannes Gehrke, *Database Management Systems*, TATA McGraw-Hill, 3rd Edition, 2003
4. C.J.Date, *An Introduction to Database Systems*, Pearson Education, 8th Edition, 2006

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book /Assignment Exam (%)
Remember	40	40	--
Understand	30	40	--
Apply	30	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any four application of DBMS
2. Define data model
3. List any four applications for triggers
4. Define functional dependency
5. List the 4 properties of Transaction

Understand

1. Explain E-R Model with suitable example
2. Explain the role of integrity constraints in database design
3. Illustrate the working principle of 'write a head log' protocol
4. Differentiate 3NF and 4NF
5. Explain Two Phase Locking Protocol

Apply

1. When multiple transactions are being executed by the operating system in a multiprogramming environment, there are possibilities that instructions of one transaction are interleaved with some other transaction. Apply the suitable concept to overcome the problem
2. Classify various normal forms according to their applicability
3. Give some real-world applications of Normalization
4. Illustrate the Commit and Rollback operations of Transaction Control
5. Give some real-world applications for Database indexing techniques

Analyze

1. Compare File processing system with DBMS
2. Analyze different locking protocol for concurrency control and serializability
3. Normalization will increase the complexity of the database design. Justify
4. Compare DDL and DML of SQL

5. Compare and Contrast Serializability and Recoverability

Evaluate

1. Is database redesign being necessary? explain
2. How can you evaluate the performance of two data models?
3. Evaluate the performance of query processor and list the corresponding metrics
4. How can you assess the throughput and delay for any DBMS?
5. How can you evaluate the impact of data models on the query processing?
6. Anitha has a large CD collection. Her friends like to borrow her CD's, and she has to keep track of who has what. She maintains a list of friends, identified by unique FID's and a list of CD's, identified by CID's. With each friend are the name and telephone numbers which she can call to get the CD back. With each CD is actor name and title. Whenever a friend borrows a CD, She will enter that fact into her database along with the date borrowed. Whenever the CD gets returned, that fact, too, gets noted along with the date returned. Anitha wants to keep a complete history of her friends' borrowing habits so that she can ask favors of the heavy borrowers.
   Draw an ER diagram to figure out the above situation and identify types of attributes and cardinality. Represent this database as a collection of 3NF relational tables. **(For Open Book Examination and not for semester end examination).**
7. The relational scheme R(A,B,C,D,E,F) and set of functional dependencies AB -> D, E -> C, AF -> B. From this, find out all super keys for this relation, and which of these super keys form a key. **(For Open Book Examination and not for semester end examination).**

23EE011 Energy Audit, Conservation and Management

3 0 0 3

Course Outcomes

1. Summarize the energy economic analysis methods
2. Outline energy auditing and management techniques.
3. Make use of energy auditing and economic analysis procedures for energy management.
4. Outline the concept of operating power factor.
5. Summarize the need for demand side management.
6. Select PF correction and DSM techniques for energy conservation.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	2	2	2			2	2	2				3		1
CO2	2	2	2			2	2	2				3		2
CO3	3	3	3			3	2	3				3		3
CO4	2	2	2			2	2	2				3		1
CO5	2	2	2			2	2	2				3		1
CO6	3	3	3			3	2	3				3		2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

UNIT-I

Introduction

Energy situation – world and India, energy consumption, conservation-need in thermal utility, Codes, standards and Legislation

Energy economic analysis--The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems

Energy Policy based on management

12 Hours

UNIT-II

Energy auditing

Introduction, Elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results, case study**.**

Electrical system optimization--The power triangle, motor horse power, power flow concept.

Concept of electric machines-AC& DC

12 Hours

UNIT-III

Electrical equipment and power factor

Electrical equipment and power factor correction and location of capacitors, energy efficient motors, lighting basics, electrical tariff, Concept of ABT.

Flexibilization in thermal power plant.

12 Hours

UNIT – IV

Demand side management

Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning, load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.

Management and Organization of Energy Conservation awareness Programs

12 Hours

Total: 48 Hours

Text books:

1. Anil Kumar, Om Prakash, Prashant Singh Chauhan, Samsher Gautam, *Energy Management Conservation and Audits*, CRC Press, 2020

2. A S. Pabla, *Electrical Power distribution*, TMH, 7th edition, 2019

References:

1. Chakrabarti, Amlan*, Energy Engineering and Management*, PHI Learning Pvt. Ltd., 2nd Edition, 2018.
2. Abdelhay A. Sallam, Om P. Malik, *Electric Distribution Systems*, Wiley, 2018.

Internal Assessment Pattern

Cognitive level	Int. Test 1 (%)	Int. Test 2 (%)	Open book /Assignment examination (%)
Remember	25	25	---
Understand	50	50	
Apply	25	25	100
Analyze	---	---	
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define Energy
2. List out various types of energy resources present in Globe
3. Define principle of energy audit
4. Define energy management and auditing
5. Define load profiles
6. Define power factor

Understand

1. Summarise the duties of energy auditor and manager
2. Explain the types of energy audit
3. Explain energy policies and IETS
4. Explain break even chart
5. Explain about depreciation with all methods
6. Explain power factor methods and controlling

Apply

1. Show how role of IT is important in EA&M
2. Demonstrate the star delta method of power factor improvement
3. Implement efficient lighting systems with Lux meter
4. Find SHR & MF and ratios of lighting with equations
5. GMRIT wants to understand the energy consumption patterns and look for scope of reducing unnecessary energy consumption and minimize wastage. In this regard, the institute sets up a team to perform an energy audit. As a member of the team, your assigned the duty of identifying the auditing method which is suitable to GMRIT. Justify your selection.
6. It was noticed that GMRIT's electricity bill is consisting a heavy amount in the kVAr category. In this regard, the management has taken a decision to identify the various causes for increased kVAr usage in the campus and take counter measures to reduce it. You are entrusted with the duty of identifying the loads consuming high kVAr and suggesting the methods to improve the same. Elaborate the methodology adopted along with suitable counter measures.

23EE012 Microprocessors and Microcontroller Interfacing

3 0 0 3

Course Outcomes

1. Illustrate the architecture of 8086 microprocessor
2. Outline assembly language programs of 8086 microprocessor
3. Select the interfacing peripherals with 8086 microprocessor
4. Summarize the architecture of 8051 microcontroller
5. Model assembly language programs of 8051 microcontroller
6. Select the interfacing of peripherals with 8051 microcontroller

CO-PO Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	2	2			1						2	2	2
CO2	3	3	2			1						2	2	2
CO3	3	3	3			1						2	2	2
CO4	3	3	3			2						2	2	2
CO5	3	3	3			2						2	2	2
CO6	3	3	3			2						2	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

8086 Microprocessors and Assembly Language Programming

Introduction to microcomputer, evolution of processors and semiconductor memories (RAM, ROM, EPROM, EEPROM), Architecture of 8086 microprocessor, Register organization of 8086, Pipelining concept, Memory segmentation, Addressing Modes.

Instruction Set and Programming: Instruction set of 8086 microprocessor: Data transfer instructions, Arithmetic instructions, Logical Instructions, String instructions, Stack related instructions, Branching instructions, Assembler directives.

Data transfer instructions of 8085 microprocessor, Architecture of 8085 microprocessor

12 Hours

Unit II

8086 Operational Modes and Memory Interfacing

Minimum and Maximum mode operations of 8086 with timing diagrams, Procedures and macros, Stack Structure of 8086, Static RAM Interfacing, Interfacing of 8255 Programmable Peripheral Interface with 8086 microprocessor.

Dynamic RAM, Direct memory access

12 Hours

Unit III

8051 Microcontroller

Comparison between microprocessor and microcontroller, 8051 family microcontroller, RAM architecture of 8051, Integrated Development Environment (IDE), Pin description of 8051 microcontroller, Machine cycle. Addressing Modes, Instruction set of 8051: Data transfer instructions, Arithmetic instructions, Logical Instructions, Stack related instructions, Branching instructions. Programing and Applications of Timers, Interrupts, Universal Asynchronous Receiver Transmitter (UART).

External memory interfacing with 8051 microcontroller, various constituents of hex file

12 Hours

Unit IV

Interfacing with 8051 microcontroller with External Peripherals

Interfacing with 8051 microcontroller with: Keypad matrix, LCD, Seven segment displays, L293D Motor driver, Stepper motor, Analog to Digital Converter (804), Digital to Analog Converter (808), introduction to CISC architecture, RISC architecture and Features of ARM processor.

Interfacing of temperature sensor (LM 35) with 8051, interfacing of relay with 8051 **12 Hours**

Total: 48 Hours

Textbook (s)

1. A.K. Ray & K. M Bhurchandi, *Advanced Microprocessors & peripherals*, Tata McGraw-Hill, 3rd Edition, 2012
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, *The 8051 Micro controller and Embedded systems: using assembles and C*, Pearson, 2nd Edition,2007.
3. Furber, *Arm System-On-Chip Architecture*, Pearson Education, 2001.

Reference (s)

1. D.V.Hall, *Microprocessor and Interfacing*, Tata McGraw Hill Publishing Company, 2nd Edition 2006
2. N. Sentil Kumar, M Sarvanan, S Jeevananthan, *Microprocessors and Microcontrollers*, Oxford University Press, 1st Edition, 2010
3. Kenneth J Ayala, *The 8051 Microcontroller Architecture, Programming and Applications*, Thomson Publishers, 3rd Edition, 2004

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Examination (%)
Remember	25	25	---
Understand	35	35	---
Apply	40	40	---
Analyze	---	---	100
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any four sixteen bit registers of 8086 microprocessor which can't split into two eight bit registers.
2. State the advantages of memory segmentation.
3. State the significance of Reset pin of 8051 microcontroller.
4. List four differences between 8051 family of microcontroller.

Understand

1. Explain the function of BIU and EU of 8086 microprocessor.
2. Explain the consequences of execution of MOV IP, #14H instruction of 8051 microcontroller.
3. Explain the structure of internal RAM of 8051 microcontroller.
4. Explain the significance of each bit of TMOD register of 8051 microcontroller.

Apply

1. Execute an ALP to perform sorting operation in ascending order on 16 bit numbers
2. Find the approximate time required to execute an ALP with the help of hardware timers
3. Execute an ALP to generate +4V (P-P) of square wave using 8086
4. Execute an ALP to blink the LED'S using 8051
5. Execute an ALP to find largest number

Analyse

1. Compare the register organization of 8086 and 80386 microprocessors
2. Outline the features of 80386 advanced microprocessor
3. Differentiate the features of 8086 microprocessors
4. Organize the instruction set for implementing stepper motor application
5. Differentiate the modes of operation of 8255

23EE013 Programmable Logic Controllers

3 0 0 3

Course Outcomes

1. Recall the basic structure and working of PLC
2. Illustrate the PLC programming formats and ladder logic fundamental concepts
3. Utilize different levels of ladder logic functions and addressing formats of File structures
4. Interpret the operation and significance of basic instruction sets like bit, timer and counter instructions
5. Classify the operation, symbols and control words of data-handling, comparison and sequencer instructions
6. Make use of PLCs for different real time applications using ladder diagrams and static application panels

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	2	2			1						2	2	2
CO2	3	3	2			1						2	2	2
CO3	3	3	3			1						2	2	2
CO4	3	3	3			2						2	2	2
CO5	3	3	3			2						2	2	2
CO6	3	3	3			2						2	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit – I

Introduction to PLC & Working of PLC

The concept of PLC, Building blocks of PLC, I/O module structure, Memory structures, Functions of various blocks, Advantages of PLCs over electromagnetic relays, list of top PLC manufacturers, Basic operation and principles of PLC.

PLC Programming: programming equipment, programming languages, Input instructions, outputs, operational procedures.

Drill press operation.

12 Hours

Unit – II

Ladder Logic & File Structure

Ladder Logic: Introduction, Basic Components & Their Symbols, Fundamentals of Ladder Diagrams – A PLC illustrated with relays, programming concepts, ladder logic inputs, ladder logic outputs. Ladder Logic Functions – Data handling functions, logical functions, List functions, input and output functions.

File Structure & Addressing Formats: Introduction, Output & Input Data Files, Status File, Bit Data File, Timer Data File, Counter Data File Elements, Control Data File, Integer Data File & Float Data File.

Boolean Logic & Relay Logic functions

12 Hours

Unit – III

Instruction Sets

Introduction, bit instructions, timer instructions, counter instructions, reset instructions, data handling instructions, comparison instructions, sequencer instructions

Reset (RES) Instruction & Sequencer Compare Instruction

12 Hours

Unit – IV

PLC Applications

Introduction, Switching ON-OFF Light, Liquid Level Control, Process Control, Main Door Control, Vehicle Parking Control, Bottling Plant, Drink Dispenser, Motor in forward and reverse direction

Traffic Light Control

12 Hours

Total: 48 Hours

Textbook (s)

1. Rajesh Mehra, Vikrant Vij, "*PLCs & SCADA: Theory & Practice*", Laxmi Publications, 2nd Edition, 2012.
2. Kelvin T Erickson, "*Programmable Logic Controllers: An Emphasis on Design and Application*", Dogwood Valley Press, 2nd Edition, 2016.

Reference (s)

1. Gary Dunning, Thomson Delmar, "*Programmable Logic Controller*", Cengage Learning, 3rd Edition, 2005.
2. W. Bolton, "*Programmable Logic Controllers*", Newnes – Elsevier, 2015.
3. Mini S Thomas, John D McDonald, "*Power System SCADA & Smart Grids*", CRC Press, Dogwood Valley Press, 2017.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book/ Assignment Examination(%)
Remember	25	20	---
Understand	50	40	---
Apply	25	40	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define PLC
2. List out PLC input devices
3. List the characteristics of PLC registers

Understand

1. Explain advantages and disadvantages of PLC in detail.
2. Illustrate the input module for PLC.
3. Explain advantages and disadvantages of PLC over electromagnetic relays.

Apply

1. Develop the rules for constructing the ladder diagram.
2. Make use of SUBTRACT function for conveyor count application with neat schematic.
3. Develop PLC ladder diagram for vehicle parking control.
4. i. Recall the basic structure and working of PLC
   ii.Illustrate the PLC programming formats
   iii.How do you identify different levels of ladder logic functions and addressing formats of File structures? **(For Open Book Examination and not for semester end examination).**
5. i. Interpret the operation and significance of timer instruction set
   ii.Classify the operation, symbols and control words of data-handling instructions
   iii.Make use of PLCs for different real time applications using ladder diagrams and static application panels.**(For Open Book Examination and not for semester end examination).**

23SIX02 Summer Internship II

0 0 0 1.5

Course Outcomes

1. Demonstrate communication skills to meet the requirement of industry
2. Develop logical thinking and analytical skills to thrive in competitive examinations
3. Use mathematical concepts to solve technical quizzes
4. Develop technical skills to work out real time problems
5. Develop algorithms for different applications
6. Solve industry defined problems using appropriate programming skills

COs – POs Mapping

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	2	3	1	3	3	3	1	3	3	1
CO2	3	3	3	3	2	2	1	3	3	1	1	3	3	2
CO3	3	2	3	2	2	1	1	3	2	3	1	2	3	1
CO4	3	3	3	3	3	3	2	3	3	3	1	3	3	2
CO5	3	3	3	3	3	3	3	3	3	3	2	3	3	2
CO6	3	3	3	3	3	3	3	2	3	3	3	3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

23PWX01 Project

0 0 16 8

Course Outcomes

1. Identify a contemporary engineering application to serve the society at large
2. Use engineering concepts and computational tools to get the desired solution
3. Justify the assembled/fabricated/developed products intended
4. Organize documents and present the project report articulating the applications of the concepts and ideas coherently
5. Demonstrate ethical and professional attributes during the project implementation
6. Execute the project in a collaborative environment

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	3	2	3	2	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	3	3	3	3	3	3
CO3	3	3	3	3	2	3	2	3	2	3	3	2	3	3
CO4	3	3	3	3	2	2	3	3	2	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

23EE014 Power System Deregulation

0 0 0 3

Course Outcomes

1. Outline the components of deregulated systems.
2. Summarize deregulated model in detail.
3. Identify the need of power system restructuring in deregulation.
4. Compute the market power mitigation techniques.
5. Summarize the total transfer capability in detail.
6. Identify the various transmission open access issues in competitive market

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1		1	2			2	1					3	2	
CO2		1	2			2	2					3	2	
CO3		2	3			2	3					3	3	
CO4		3	3			2	3					3	3	
CO5		1	2			2	2					3	2	
CO6		2	3			2	3					3	3	

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT- I

Introduction to Power System Deregulation

Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantages of competitive system

Regulation VS deregulation

12 Hours

UNIT- II

Power System Restructuring

Difference between integrated power system and restructured power system. Explanation with suitable practical examples. Deregulation of Power Sector: Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, Multilateral trade model.

Day ahead and hour ahead markets

12 Hours

UNIT- III

Competitive Electricity Market

Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services, Transmission Pricing-postage stamp, MW-mile.

Location based Marginal Pricing LMPs

12 Hours

UNIT- IV

Transmission Open Access Issues

Open Access Same Time Information System-structure, functionality, implementation, posting of information, uses, Congestion Management-Congestion management in normal operation, total transfer capability, Available transfer capability, Transmission Reliability Margin, Capacity Benefit Margin, Existing Transmission Commitments.

Tracing of power

12 Hours

Total: 48 Hours

Textbook (s)

1. *Power System Restructuring and Deregulation* by Loi Lei Lai, John Wiley & Sons Ltd
2. *Understanding Electric Utilities and Deregulation* by Lorrin Philipson and H. Lee Willis, Marcel Dekker Inc, New York, CRC Press.

Reference (s)

1. *Electric Utility Planning and regulation* – Edward Kahn , University of California- 2005
2. M. Shahidehpour and M. Alomoush, "*Restructured Electric Power Systems – Operations, Trading and Volatility*", CRC Press, 2001.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Examination (%)
Remember	25	25	---
Understand	35	35	---
Apply	40	40	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define optimal power flow?
2. List factors affecting power system security?
3. Label State estimation in power system?
4. List the benefits of deregulation?

Understand

1. Explain interior point algorithm?
2. Explain concentric relaxation?
3. Explain state estimation by orthogonal decomposition?
4. Explain the operation of deregulated power markets?

Apply

1. Identify the best linear programming method?
2. Identify the various problems in network?
3. Utilize state estimation for detection and identification of Bad measurements Estimation?
4. Identify the various electrical market entities?

23EEC23 Power System Dynamics & Control

0 0 0 3

Course outcomes

1. Outline various power system stability states
2. Illustrate the excitation system for standard model
3. Build the standard model for synchronous machine
4. Outline the stability model for the given system
5. Summarize the structure and tuning of power system stabilizer
6. Identify the control and stability model for single machine system

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	3	2					1				1	3	3
CO2	3	3	3					1				1	3	3
CO3	3	3	3					1				2	3	3
CO4	3	3	3					1				2	3	3
CO5	3	3	2					1				2	3	3
CO6	3	3	2					1				2	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit- I

Modeling of Synchronous Machine: Power system stability states of operation and system security – system dynamics – problems system model analysis of steady State stability and transient stability – simplified representation of Excitation control-Synchronous machine – park's Transformation-analysis of steady state performance per – unit quantities-Equivalent circuits of synchronous machine determination of parameters of equivalent circuits.

per – unit quantities

12 Hours

Unit- II

Excitation System: Excitation system modeling-excitation systems block Diagram – system representation by state equations- Dynamics of a synchronous generator connected to infinite bus – system model Synchronous machine model-stator equations rotor equations – Synchronous machine model with field circuit – one equivalent damper winding on q axis (model 1.1).

Calculation of Initial conditions

12 Hours

Unit-III

Analysis of Single Machine System: Small signal analysis with block diagram – Representation Characteristic equation and application of Routh Hurwitz criterion- synchronizing and damping torque analysis-small signal model – State equations.

Routh Hurwitz criterion

12 Hours

Unit-IV

Application of Power System Stabilizers: Basic concepts in applying PSS – Control signals – Structure and tuning of PSS – Washout circuit – Dynamic compensator analysis of single machine infinite bus system with and without PSS.

Power Transfer capacity of single machine system

12 Hours
Total: 48 Hours

Text books:

1. K. R. PADIYAR," *Power system dynamics* "- B.S. Publications, 2020.
2. P.M. Anderson and A. A. Fouad, "*Power system control and stability*", IEEE Press, 2020

Reference book:

1. R. Ramanujam, "*Power Systems Dynamics*"- PHI Publications Tester J. W. (et al.) (2012)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book /Assignment Examination (%)
Remember	30	30	---
Understand	30	30	---
Apply	40	40	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Remember

1. Define power system stability
2. List any two power system stability states.
3. Define synchronous torque coefficient.
4. List any four applications of power system stabilizer.

Understand

1. Explain steady state performance of synchronous machine.
2. Outline Dynamics of a synchronous generator connected to infinite bus.
3. Explain damping torque analysis of synchronous machine.
4. Outline dynamic compensator analysis of single machine infinite bus system with PSS.

Apply

1. Build park's Transformation model for synchronous machine.
2. Model stator equations and rotor equations for synchronous machine.
3. Identify different converters required for hybrid wind-PV system and discuss their significance.
4. Identify different parameters need to be considered in design of hybrid wind and solar system.

23EE016 High Voltage Engineering

0 0 0 3

Course Outcomes

1. Outline the behavior of gas, solids and liquids when they are used as insulating medium
2. Outline the gas, solids and liquid insulating materials
3. Identify the applications and breakdown phenomenon in insulating materials
4. Illustrate the concepts used for high voltages and currents the generation
5. Identify the suitable high voltage testing methods.
6. Outline over Voltage measurement and Insulation Co-Ordination.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	3	2			2		1				1	3	3
CO2	3	3	2			2		1				1	3	3
CO3	3	3	3			2		1				2	3	3
CO4	3	3	3			3		2				2	3	3
CO5	3	3	3			3		2				2	3	3
CO6	3	3	2			3		2				2	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT I

Introduction to High Voltage Technology and Applications

Electric Field Stresses, Gas / Vacuum as Insulator, Liquid Dielectrics, Solids and Composites, Surge voltages, their distribution and control, Applications of insulating materials in transformers, rotating machines, cable power capacitors and bushings.

Applications of circuit breakers

12Hours

UNIT-II

Break Down In Gaseous, Liquids and Solid Dielectrics

Breakdown in Gases: Gases as insulating media, collision process, Ionization process, Townsend's criteria of Breakdown in gases, Paschen's law. Breakdown in Liquids: Liquid as Insulator, pure and commercial liquids, breakdown in pure and commercial liquids. Breakdown in Solids: Intrinsic breakdown, electromechanical breakdown, thermal breakdown, breakdown of solid dielectrics in practice.

Solid dielectrics used in practice

12 Hours

UNIT-III

Generation, Measurement and Testing of High Voltages and Currents

Generation of High Direct Current Voltages, Generation of High alternating voltages, Tripping and control of impulse generators. Measurement: Measurement of High Direct Current voltages, Measurement of High alternating Voltages, Measurement of High DC Currents, alternating Measurement of Dielectric.

Measurement of loss factor

12 Hour

UNIT – IV

Testing, Over Voltage Phenomenon and Insulation Co-Ordination

Testing: Testing of Insulators and bushings, Testing of Isolators and circuit breakers, testing of cables, Testing of Transformers. Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, Principles of Insulation Coordination on High voltage.

Testing of Surge Arresters

12 Hours

Total: 48 Hours

Textbook (s)

1. *High Voltage Engineering* by M.S.Naidu and V. Kamaraju – TMH Publications, 5th Edition, 2013.
2. *High Voltage Engineering* by C.L.Wadhwa, New Age Internationals (P) Limited, 4th edition, 2020.

Reference (s)

1. *High Voltage Engineering: Fundamentals* by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition, 2000.
2. *High Voltage Insulation Engineering* by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1st edition, 2016.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book/Assignment Examination (%)
Remember	20	20	---
Understand	50	50	---
Apply	30	30	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define Field enhancement factor.
2. Define the mean free path (λ).
3. Define "Complex permittivity.

Understand

1. Illustrate the numerical methods used for electric field computation? Explain briefly about Finite difference method (FDM).
2. What is ionization process? Explain about all types in ionization process.
3. Derive the current growth equation for Townsend's criteria for breakdown with neat sketch.

Apply

1. Apply the partial discharge tests on high voltage cables. How a fault in the cable insulation can be located by using partial discharge technique
2. Identify different controlling methods of over voltages due to switching operations? Explain them briefly
3. Identify different testing methods suitable for testing of isolators and circuit breakers.
4. Make use of the given data and give solution. The line voltage of a 2-wire direct current increased from 100 v to 200v if the same amount of the same electrical power is transmitted over the same distance, what will be the percentage of saving in copper. **(For open book Examination not for semester end examination)**
5. Develop a surge arrester that can withstand high range current that can takes place at rainy season. Assume the required data.**(For open book Examination not for semester end examination)**

23F1X01 Full Semester Internship

0 0 0 9

Course Outcomes

1. Use the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3. Select appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
4. Use ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
5. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
6. Communicate effectively on complex engineering activities with the engineering community and with 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

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}	PSO_1	PSO_2
CO1	3	3	3	2	3	2	2	2	2	2	2	2	3	3
CO2	3	3	3	3	3	2	2	2	2	2	2	2	3	3
CO3	3	3	3	2	3	3	3	2	2	2	3	2	3	3
CO4	2	2	2	3	3	3	3	2	2	2	3	2	2	3
CO5	2	2	3	3	3	3	3	2	2	3	3	3	3	3
CO6	3	3	3	3	3	3	3	2	2	3	3	3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked